



MINISTRY OF ENERGY
AND PETROLEUM



KILIFI COUNTY GOVERNMENT

KILIFI COUNTY ENERGY PLAN 2025-2034



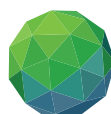


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List of Abbreviations and Acronyms

ABPL	Africa Bioenergy Program Limited
ACSR	Aluminium conductor steel-reinforced cable
ADPs	Annual Development Plans
AEEE	Alliance for an Energy Efficient Economy
AEZs	Agro-Ecological Zones
AFD	Agence Française de Développement
AMREF	African Medical and Research Foundation
APHIAplus	AIDS, Population and Health Integrated Assistance
ArcGIS	Aeronautical Reconnaissance Coverage Geographic Information System
ASALS	Arid and Semi-Arid Lands
ASFADA	Arabuko-Sokoke Forest Adjacent Dwellers Association
ATC	Agriculture Training Center
BCC	Behaviour Change Communication
BPS	Bulk Power Supply Station
BS ISO	British Standard International Organization for Standardization
BSP	Bulk Supply Point
CAPEX	Capital Expenditure
CBO	Community Based Organization



CCAK	Clean Cooking Association of Kenya
CCS SPs	Clean Cooking Solutions Service Providers
CDA	Coast Development Authority
CEC	County Executive Committee
CEEC	Centre for Energy Efficiency and Conservation
CECM	County Executive Committee Member
CEP	County Energy Plan
CEPC	County Energy Planning Committee
CETC	County Energy Technical Committee
CFLs	Compact Fluorescent Lamps
CGK	County Government of Kilifi
CH ₄	Methane
CHP	Combined Heat and Power
CIDP	County Integrated Development Plan
CO ₂	Carbon dioxide
COD	Commercial Operation Date
CoG	Council of Governors
CSOs	Civil Society Organizations
DC	Direct Current
DEM	Digital Elevation Model
DFID	Department for International Development
DTI	Danish Technology Institute
ECDE	Early Childhood Development and Education
ECOHEATCOOL	European heating and cooling
EE&C	Energy Efficiency and Conservation
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EMCA	Environmental Management and Coordination Act
EnMS	Energy Management Systems
EPC	Electric Pressure Cooker
EPRA	Energy and Petroleum Regulatory Authority
ERC	Energy Regulatory Commission
EU	European Union
EVs	Electric vehicles
FAO	Food and Agricultural Organization



FGDs	Focused Group Discussions
FiT	Feed-In-Tariff
FW	Firewood
GCF	Green Climate Fund
GCP	Gross County Product
GDC	Geothermal Development Company
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GEOSIM	Geospatial Simulation Model
Genset	Generator set
GESIP	Green Economy Strategy and Implementation Plan
GHGs	Greenhouse Gases
GHI	Global Horizontal Irradiation
GIS	Geographic Information System
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GLCC	Global Land Cover Characterization
GoK	Government of Kenya
GPOBA	Global Partnership on Output-based Aid
GROOTS	Grassroots Organisations Operating Together in sisterhood
GSA	Global Solar Atlas
GTF	Global Tracking Framework
GWA	Global Wind Atlas
HAP	Household air pollution
HC	Health Center
HDU	High dependency unit
H.E.	His Excellency
HH	Household
HIV/AIDS	Human immunodeficiency virus/ Acquired immunodeficiency syndrome
HV	High Voltage
ICS	Improved Cookstove
ICT	Information Communication Technology
ICU	Intensive care unit
IEA	International Energy Agency
IEBC	Independent Electoral and Boundaries Commission
IFC	International Finance Corporation



INEP	Integrated National Energy Plan
INGOs	International Non-Governmental Organizations
IPP	Independent Power Producer
IRENA	International Renewable Energy Agency
IRR	Internal rate of return
ISO	International Organization for Standardization
KAM	Kenya Association of Manufacturers
KCA	Kenya Civil Aviation
Kcal	Kilo Calories
KCAP	Kenya Country Action Plan
KCEP	Kilifi County Energy Plan
KCEP-CRAL	Kenya Cereal Enhancement Programme–Climate Resilient Agricultural Livelihood Window
KCJ	Kenya Ceramic Jiko
KDHS	Kenya Demographic Health Survey
KEBS	Kenya Bureau of Standards
KEFRI	Kenya Forestry Research Institute
KenGen	Kenya Electricity Generating Company
KEPSA	Kenya Private Sector Alliance
KEREA	Kenya Renewable Energy Association
KES	Kenya Shillings
KETRACO	Kenya Electricity Transmission Company
KFS	Kenya Forest Service
KIIs	Key Informant Interviews
KIMAWASCO	Kilifi Mariakani Water And Sewerage Company Limited
KNBS	Kenya National Bureau of Statistics
KNECCS	Kenya National Efficiency and Conservation Strategy
KNES	Kenya National Electrification Strategy
KOSAP	Kenya off-grid Solar Access Project
KPC	Kenya Pipeline Company
KPLC	Kenya Power and Lighting Company
KPRL	Kenya Petroleum Refineries Limited
KRAs	Key Result Areas
KS	Kenya Standard
LCEP	Least Cost Electrification Plan
LCOE	Levelized Cost of Electricity



LCPDP	Least Cost Power Development Plan
LCV	Low Calorific Value
LED	Light Emitting Diode
LFG	Landfill Gas
LFGC	Landfill Gas Capture
LFGP	Landfill Gas Potential
LMCP	Last Mile Connectivity Project
LN	Legal Notice No.
LPG	Liquefied Petroleum Gas
LTP	Long Term Plan
LULC	Land Use and Land Cover
LV	Low Voltage
M&E	Monitoring and Evaluation
MCA	Member of County Assembly
MDAs	Ministries, Departments, and Agencies
MEC	Modern Electric Cooking
MEPS	Minimum Energy Performance Standards
MoEP	Ministry of Energy and Petroleum
MPPT	Maximum Power Point Tracking
MRF	Materials Recovery Facility
MSME	Micro-, Small and Medium-sized Enterprises
MSW	Municipal Solid Waste
MTEF	Medium Term Expenditure Framework
MTF	Multi-Tier Framework
MTP	Medium Term Plan
MV	Medium Voltage
N/B	Note
NCCAP	National Climate Change Action Plan
NDC	Nationally Determined Contributions
NDMA	National Disaster Management Authority
NEMA	National Environment Management Authority
NG-CDF	National Government Constituency Development Fund
NGOs	Non-Governmental Organizations
NIA	National Irrigation Authority
NIB	National Irrigation Board of Kenya



NMT	Non-Motorized Transport
NOCK	National Oil Corporation of Kenya
NPV	Net Present Value
NTSA	National Transport and Safety Authority
NuPEA	Nuclear Power and Energy Agency
OPEX	Operating Expenses
OVCs	Orphans and Vulnerable Children
Pax	Per person
PAYG	pay-as-you-go
PPAs	Power Purchase Agreements
PPP	Public Private Partnership
PS	Primary Substation
PUE	Productive use of Energy
PV	Photovoltaic
PVOUT	PV Power Output
PWDs	Persons Living with Disability
RBF	Results-Based Financing
REREC	Rural Electrification and Renewable Energy Corporation
RoR	Run-of-the-river
SACCO	Savings and Credit Cooperative Organisation
SCADA	Supervisory Control and Data Acquisition
SCH	Sub-County Hospital
SDE	State Department for Energy
SDGs	Sustainable Development Goals
SEACAP	Sustainable Energy Access and Climate Action Plan
SEforALL	Sustainable Energy for All
SEP	Slum Electrification Project
SETA	Sustainable Energy Technical Assistance
SGR	Standard Gauge Railway
SHS	Solar Home System
SLF	Sanitary Landfill
SMEs	Small and Medium-sized Enterprises
SNV	Stichting Nederlandse Vrijwilligers
SSP RBF	Solar Service Providers Results-Based Financing
SWERA	Solar and Wind Energy Resource Assessment



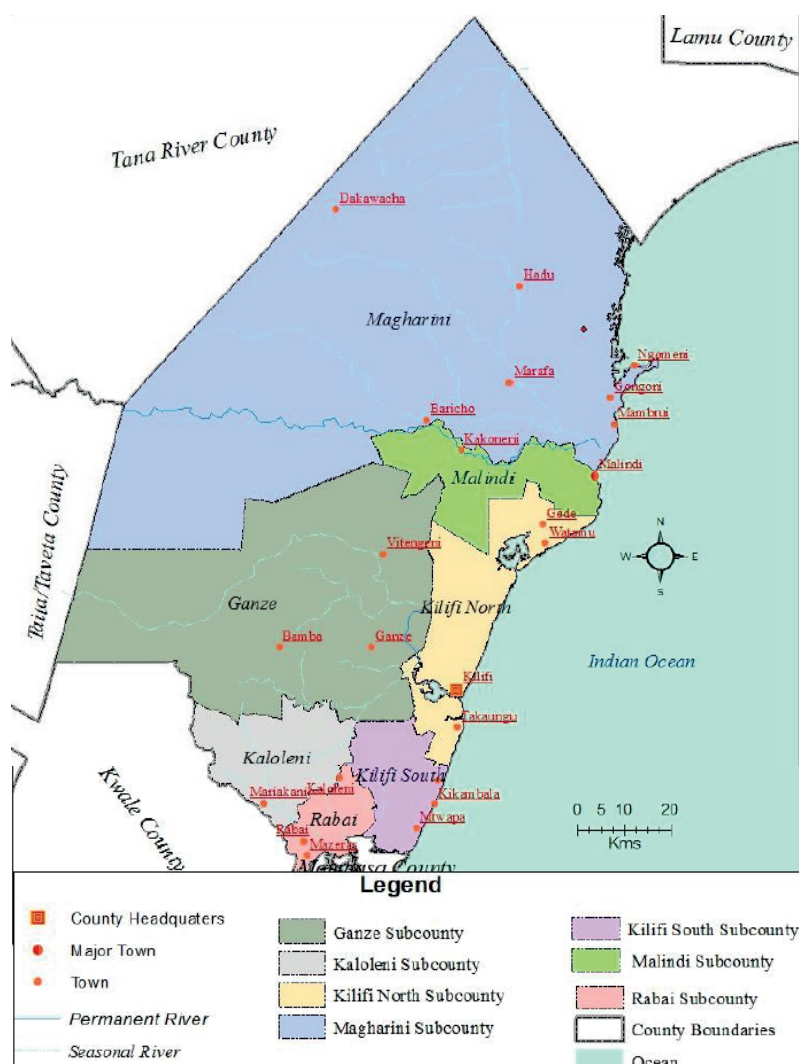
SWH	Solar Water Heating
TC	Technical Committee
TOR	Terms of Reference
TSOF	Three-Stone Open Fire
TVCs	Technology Value Chains
TVET	Technical and Vocational Education and Training
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UNOPS	United Nations Office for Project Services
USD	United States Dollar
VAT	Value-added tax
VTC	Vocational and Technical College
WB	World Bank
WFP	World Food Programme
WHO	World Health Organization
WHO	World Health Organisation
WtE	Waste-to-energy
WWF	World Wide Fund for Nature

Units of Measurements

GJ	gigajoule	kWh/hr/m ²	kilowatt-hour/hour/metre squared
GWh	gigawatt hour	kWp	kilowatt peak
GWp	gigawatt peak	m ²	Square metre
Ha	Hectare	m ³	Cubic metre
kg	kilogramme	MJ	megajoule
kJ	kilojoule	MVA	megavolt-amperes
km	kilometre	MW	megawatt
km ²	Square kilometre	MWh	megawatt-hour
Koe	Kilogramme of oil equivalent	V	Voltage
kV	kilovolt	Vcd	Volume of cow dung digester
kVA	kilovolt-amperes	Vhw	Volume of human waste digester
kW	kilowatt	W	Watt
kWa	kilowatt available	Wp	Watt peak
kWh	kilowatt-hour		



MISSION AND VISION



County Energy Plan Mission

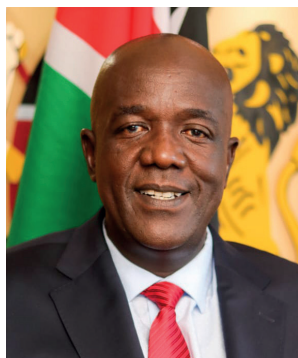
Ensuring access to affordable, reliable, and sustainable energy that fosters socio-economic development for all residents of our great county.

County Energy Plan Vision

We envision a future where universal energy access, affordability, efficiency, and innovation drive economic prosperity, environmental conservation, and an enhanced quality of life across households, businesses, industries, and institutions.



FOREWORD



I am delighted to present to you the Kilifi County Energy Plan (KCEP) 2024–2030 developed to fulfil the requirements of the Constitution of Kenya as well as the Energy Act 2019. The Fourth Schedule of the Constitution allocates energy roles between the national and county governments. Part 1 of the Fourth Schedule provides that the national government shall be responsible for energy policy, including electricity and gas reticulation and energy regulation; while in Part 2 it provides that the county governments shall be responsible for county planning and development, including electricity and gas reticulation and energy regulation. Therefore, energy is a shared function of both the national and

county governments. Part II (Energy Policy and Plan), Regulation 5(3) of the Energy Act 2019, which states *“Each County Government shall develop and submit a county energy plan to the Cabinet Secretary in respect of its energy requirements.”*

The objectives of the KCEP are based on National Energy Goals derived from Sustainable Development Goals (SDG) 2015–2030, specifically Goal 7, which targets Access to affordable, Reliable, Sustainable and Modern Energy for All by 2030. The Plan was backdated in order to align it with the National Plan and County Government Planning cycle, Medium Term Plan (MTP) and the County Integrated Development Plan (CIDP) respectively.

As we embark on the implementation of this Plan, we are guided by a vision of ensuring universal access to clean, reliable, and affordable energy for all residents of Kilifi County. Through strategic investments, innovative approaches, and a focus on sustainability, we aim to transform the energy landscape of our county and unlock new opportunities for growth and development.

I would like to extend my sincere gratitude to all those who have contributed to the development of this Plan. Your dedication, expertise, and commitment have been instrumental in shaping this document and laying the foundation for our energy future.

A handwritten signature in black ink, appearing to read 'G. Maitha Mung'aro', written over a light blue horizontal line.

H.E. GIDEON MAITHA MUNG'ARO

Governor

County Government of Kilifi



PREFACE



This plan was crafted in accordance with the Constitution of Kenya 2010, which decentralised certain roles of the national government to counties, including energy planning. Additionally, it adheres to the Energy Act of 2019, which provides the framework for the development of county energy plans to be integrated into the Integrated National Energy Plan (INEP).

The rationale behind devolving the energy planning process is rooted in the recognition that, historically, this process was centralised at the national level, often overlooking the diverse energy needs, resources, and potential of each region. Consequently, significant portions of the country were neglected in these plans, resulting in an inequitable distribution of energy resources and investments nationwide.

This comprehensive plan encompasses input from all seven sub-counties: Kilifi South, Kilifi North, Rabai, Kaloleni, Malindi, Ganze, and Magarini, reflecting the diverse energy access levels across our county accurately. The inclusion of community perspectives ensures that the plan captures the true essence of our county's energy landscape. This authenticity is further reinforced by baseline surveys conducted among households, public facilities, and Small and Medium-sized Enterprises (SMEs), shedding light on the current energy access status and identifying existing gaps.

In my capacity as the County Executive Committee Member (CECM) responsible for this directorate and chair of the County Energy Planning Committee (CEPC), I am committed to mobilizing all available resources, both locally and through partnerships, to ensure the meticulous implementation of this plan. Our overarching goal is to meet the national goal of universal access to clean cooking energy and electricity by the year 2027, thereby enhancing the quality of life for all residents of Kilifi County.

HON. JANE KAMTO

County Executive Committee Member (CECM)—Department of Lands, Energy, Housing, Physical Planning, and Urban Development
County Government of Kilifi



ACKNOWLEDGEMENT



First and foremost, as the county government of Kilifi County, we wish to extend our sincere gratitude to the Sustainable Energy Technical Assistance (SETA) team led by Jechoniah Kitale, in collaboration with other esteemed institutions including the Ministry of Energy and Petroleum (MoEP), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) Kenya, World Wide Fund for Nature (WWF), and under voices for just climate action Clean Cooking Association of Kenya (CCAK), and Joy Bringers Community Based Organization along with all other partners who generously funded and actively participated in this comprehensive process since its inception in 2021. We deeply appreciate the decision to include our county among the pioneering few to develop their county energy plans.

Secondly, we wish to express our heartfelt gratitude to all the stakeholders within our county, as well as other county departments such as health, water, education, agriculture, livestock, environment and climate change, mining, and economic planning. Additionally, we extend our appreciation to key state agencies including the Kenya Power and Lighting Company (KPLC), the Rural Electrification and Renewable Energy Corporation (REREC), the Kenya Off-grid Solar Access Project (KOSAP), the National Environment Management Authority (NEMA), the Kenya Forest Service (KFS), and many others for the provision of essential data and information which have been integral to the formulation of this County Energy Plan (CEP) document.

We wish to express our sincere gratitude to all staff in the department of Lands, Energy, Physical Planning and Urban Development whose valuable input contributed immensely to the successful development of this Plan. We wish to single out Mr. Wilfred Baya—Energy Assistant Director for his outstanding supervisory, technical and logistical support that ensured successful completion of this plan.

Lastly, we would like to acknowledge the commendable efforts of our consultants, Mr. James Gatimu and Mr. Edwin Nateminya, who worked tirelessly to ensure that all relevant information regarding our county's energy needs was thoroughly documented and presented. Collectively, these partners and stakeholders have played a pivotal role in the development of a reputable CEP that aligns with our county's energy requirements.

JOE TETE

Chief Officer—Department of Lands, Energy, Housing, Physical Planning, and Urban Development
County Government of Kilifi



EXECUTIVE SUMMARY

Energy access is a critical prime mover which propels socio-economic development. It serves as a cornerstone for entrenching progress across various sectors essential for human well-being. At the household level, energy access directly influences the quality of life, enabling essential activities such as cooking, heating, and lighting. In health care, energy plays a pivotal role in enhancing healthcare services by powering medical equipment, refrigeration for vaccines and medicines, and providing electricity for lighting in health facilities. In the education sector, energy facilitates learning through the provision of lighting for study purposes, powering electronic devices, and supporting integration of Information Communication Technology (ICT) into learning activities. Additionally, energy is indispensable for agricultural activities, including irrigation, processing, and storage, thereby contributing to food security and livelihood enhancement. In regards to water access and sanitation systems, energy is needed for pumping, purification, and reticulation, ensuring clean and safe water for communities. In essence, energy access provides the foundation for socio-economic development, driving progress and prosperity across all facets of human existence.

The Energy Act of 2019 (section 5 and 5th schedule), the INEP framework and the draft Energy (INEP) regulations of 2023 provide for integrated energy planning where the county governments are required to prepare CEPs. These plans will be forwarded to the Cabinet Secretary for Energy and consolidated into one national integrated plan which will guide the implementation of energy projects and programmes in the country. The CEPs will guide implementation of energy projects in the county for 10 years and will be reviewed every 3 years on a rolling basis.

This CEP for Kilifi County has been developed to comply with the above requirements while also providing a road map for mainstreaming energy access issues into the county's development agenda. Its contents have been informed by detailed baseline data analysis and extensive stakeholders' consultations. Though the plan is supposed to cover a period of 10 years, it was agreed, through the deliberations of the County Energy Technical Committee, to tie, to the extent possible, the energy access projects to the life of CIDP3. As such, most projects have been scheduled to run from 2023 to 2027. They are a few projects, however, namely the least cost electrification planning and the biogas project for households, which are envisioned to continue until 2030. In line with INEP regulations, this plan will be due for review in the year 2028.

The document is structured into 8 primary chapters, each addressing specific aspects of the county energy landscape and development objectives.

Chapter 1 is on introduction. It captures the captures the process of developing this document, explores the modalities of integrating the CEP and CIDP3, provides a high-level overview of the county development and demographic indicators, and the energy access profile, and finally examines the national level and the county level policies and regulations which are relevant to energy planning.

Chapter 2 takes stock of the county's energy resources. Specifically, the chapter delves into wood fuel, agricultural residues, livestock population and the feasibility of biogas generation from livestock waste, municipal solid waste, hydro, solar and wind resources.



Chapter 3 is on energy access. It has two sub topics namely; electricity access and access to clean cooking services. Under electricity access, the focus is on households, educational institutions, health facilities, agri-based facilities, irrigation, water access, and street lighting. The plan documents the status of electricity access and proceeds to propose interventions to achieve universal electricity access. With respect to access to clean cooking services, the focus is on households, educational institutions and health facilities.

Chapter 4 focuses on Energy Efficiency and Conservation (EE&C), outlining various measures aimed at promoting efficiency across different sectors, such as households, buildings, industries, and transportation. The Energy Act of 2019, sections 193, 194, 195, and 196 has given county governments a very broad mandate when it comes to championing of EE&C matters in the county. Section 193 mandates the county governments to take all measures necessary to promote efficient use of energy and its conservation in buildings, industries, agriculture, transport sector, and households.

Chapter 5 delves into bioenergy resources, highlighting various aspects such as the potential for biogas generated from livestock waste for households use, the potential for biogas generated from human waste for institutional applications, potential for harvesting landfill gas from sanitary landfills at the main dumping sites, and the bioethanol fuel.

Chapter 6 documents projects and programmes which need to be implemented so as to achieve energy access objectives detailed under chapters 3, 4, and 5. Realisation of these objectives will require concerted efforts and unity of purpose across the national government, the county government, development partners, and the private sector. To facilitate clarity and accountability, the projects are categorised according to the implementing agency responsible for their execution.

Chapter 7 presents the implementation, coordination, monitoring, and evaluation framework. This section delineates the mechanisms and structures required to execute, coordinate, and assess the progress of the energy plan. It outlines roles, responsibilities, and monitoring protocols to ensure effective implementation and the attainment of set targets.

Finally, chapter 8 is on conclusions. A salient recommendation is on the necessity to enhance the skills within the energy department for successful implementation of the CEP and the Realisation of its objectives. There is also need to prepare a framework upon which the implementation of this plan will be anchored, and an investment prospectus to showcase existing opportunities to the private sector. It's envisioned that the CEP will be able to inform future all Annual Development Plans (ADPs) 2024–25, 2025–26, 2027–28, and will ultimately propel energy access matters into the heart of county development agenda.



Chapter 1: BACKGROUND INFORMATION

1.1 Introduction

This Kilifi County Energy Plan (KCEP) covers the period of 2024–2027, is in alignment with the end date for Kilifi CIDP 2023–2027. The purpose of this Plan is to guide the Kilifi County Government to develop and implement energy programmes that are in line with the National Government priority, which includes the Sustainable Development Goal (SDG) 7. SDG7 calls for “affordable, reliable, sustainable, and modern energy for all” by 2030. Its 3 core goals are:

1. Ensure universal access to affordable, reliable, and modern energy services
2. Increase substantially the share of renewable energy in the global energy mix
3. Double the global rate of improvement in energy efficiency

This document is a master plan to guide the development of the energy sector by various stakeholders, both from the public and private sector, in Kilifi County. The Plan serves as a guide to investment in the energy sector in Kilifi County.

1.2 The Goals

Kilifi County Government has adopted the ambitious national goals for the energy sector, as indicated in Table 1. The national government targets to have universal access to electricity for lighting and modern cooking services by 2026 and 2028, respectively. This energy plan consists of actions to be implemented between 2024 and 2027 by Kilifi County Government in order to achieve the goals set in the plan.

Table 1: Energy Targets

Universal access to modern energy services		Doubling global rate of improvement of energy efficiency	Doubling share of renewable energy in the global energy mix	
Percentage of population with electricity access	Percentage of population with access to modern cooking solutions	Rate of improvement in energy efficiency	Renewable energy share in total Final energy consumption	
			Power	Heat
100%	100%	Include -2.785%	80%	80%

Source: (G.o.K, Ministry of Energy and Petroleum, December 2015)



1.3 Rationale

The development of the KCEP (2023–2027) will support the County Government in implementing devolved energy functions as indicated in the Constitution of Kenya and further elaborated in the Energy Act 2019 and the draft Energy (INEP) Regulations, 2021. The Fourth Schedule of the Constitution distributes energy roles between the national and county governments. Part 2 of the Fourth Schedule provides that the county governments shall be responsible for county planning and development, including electricity and gas reticulation and energy regulation. Clause 5(3) of the Energy Act 2019, which states “Each County Government shall develop and submit its county energy plan to the Cabinet Secretary in respect of its energy requirements.”

Kilifi County envisages itself to be a leading, vibrant, highly productive, secure, and prosperous county, providing a high quality of life for all its inhabitants (Kilifi County Government, May 2023). To achieve this vision, the county is focused on creating an enabling environment for efficient utilisation of resources, industrial growth, and effective provision of essential services for improved quality of life for all. In line with its vision and mission, the County identified priority action areas, which include food security; affordable housing and human settlement; manufacturing, tourism, trade and commerce, education, and affordable healthcare, to be implemented under the socio-economic pillar of Kenya’s Vision 2030. The KCEP will help the County Government to develop its energy sector to power its socio-economic development agenda.

1.4 Background of KCEP

This first KCEP (2024–2024) was developed to meet the requirements of the Constitution of Kenya as well as the Energy Act 2019. The Plan is aligned to the CIDP, the strategic tool for implementation of Kenya’s economic development blueprint, Vision 2030 at the County Government level. The development of the KCEP was guided by article 5(3) and 5(5), section B of the fifth schedule of the Energy Act 2019. According to article 5(5), the development of the CEP shall:

- a) take into account the national energy policy;
- b) serve as a guide for energy infrastructure investments;
- c) take into account all viable energy supply options; and
- d) guide the selection of the appropriate technology to meet energy demand.

According to section B of the fifth schedule of the energy Act 2019, the County Energy Planning should:

- a) Incorporate petroleum, renewable energy and electricity master plans;
- b) take into account physical planning relating to energy resource areas such as dams, solar and wind farms, municipal waste dumpsites, agricultural and animal waste, ocean energy, woodlots and plantations for producing bio energy feedstock;
- c) Provision of land and rights of way for energy infrastructure;
- d) Facilitation of energy demand by planning for industrial parks and other energy consuming activities;
- e) Preparation and implementation of disaster management plans.



1.5 Process of Development of the KCEP

The development of this Plan was done according to the County Energy Planning Template provided by the National Government through the Ministry of Energy. The template is part of the Integrated National Energy Planning Framework. The process of developing the KCEP was led by the County Department of Energy and involved consultations with various development partners, the National Government, Parastatals, departments in Kilifi County government, private sector actors, and Civil Society Organizations (CSOs). The process was financed by WWF, SETA Project, CCAK, and GIZ. It was conducted in four key stages.

1st Phase:

Stage 1: Brainstorming meeting

This was the first meeting between the SETA team and the officers from the energy department of Kilifi County Government. The meeting was chaired by the Chief Officer and discussed the process through which the KCEP would be developed. The objective of the meeting was to request the officers from the department to provide a list of projects from their departments that have energy components so that they can be captured in the Kilifi Energy Plan.

Stage 2: Baseline data collection

This phase involved primary and secondary data collection on energy. Primary data on energy was performed through household surveys, institutional surveys, and key informant interviews, which involved administering a questionnaire to various informants, including ward administrators, officers working in education, agriculture, trade and industrial development, water, and the private sector. In addition, community engagement workshops were carried out across all the seven sub-counties in the County. These workshops were supported financially and technically by SETA and WWF and led by the County government.

Focused Group Discussions (FGDs): A total of 35 stakeholders participated in the workshop held on 23rd September 2022. The participants were drawn from the National Government (MoEP, Kenya Power, REREC, KFS), the county government (Departments of Energy, Health, Trade and Industry, Planning, Education), Kilifi County Municipality, Kilifi–Mariakani Water Company, SETA Project Team, Energy 4 Impact, Joybringers, and The Nature Kenya. The stakeholders were grouped into five sectors, which included Clean Cooking, Trade and Industry, Education, Water, and Education.

Literature review was carried out to obtain energy data from secondary sources. Various documents, including CIDP, Kenya National Bureau of Statistics (KNBS) Census 2019, County Statistical Abstract, Energy policies, and recent County planning documents, were reviewed.



Stage 3: Needs assessment linked to main priorities

A long list of priorities was established as a result of the key activities of the baseline and key findings from the baseline. The priorities were identified at household, community, and County levels, focusing on macro-economic development (development of activity sectors, trade and industry) and the development of energy sources. This resulted in the development of goals and strategies that will deliver on the identified priorities.

Stage 4: Drafting of the zero draft Kilifi County Energy Plan

Consolidation of the vision, mission, goals, and strategies to develop the zero draft KCEP. The zero draft will be subjected to a technical committee's work and Members of the County Assembly before being validated and approved.

1.6 Integration of KCEP into CIDP Process

The MTP is the National Government's tool for implementing Kenya's socio-economic development blueprint, Vision 2030. The current CIDP 2023–2027 is aligned with the National Government MTP (IV) 2023–2027 as well as the SDGs. Some of the activities to be implemented by KCEP are captured in the CIDP 2023–2027. CIDP is the expenditure tool for the county.

CIDP targets are supported by priority actions and investment opportunities that focus on the short-term or transitional period, as additional actions and related investment projects will be added as part of the operationalisation of CIDP and beyond. As Kilifi integrates CEP into its county planning, the progression towards the county's KCEP goals is informed by the following phases:

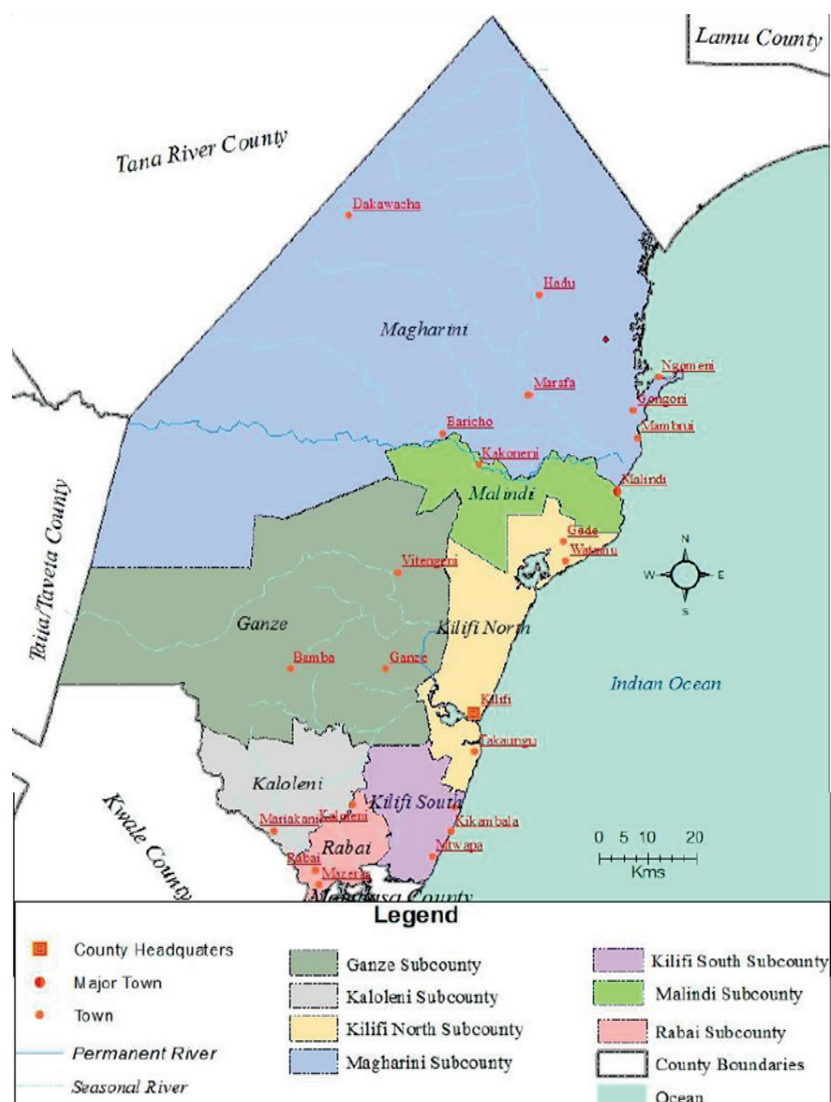
- **Transition (2023–2027).** During this period—current CIDP 3—the county continues with its current strategies and starts planning towards the adaptation, update, and alignment of the existing interventions under the KCEP agenda. During this period, all new strategies and interventions will have to be consistent with Kenya's Energy Sectoral Plan and Objectives.
- **Phase I (2028–2032).** KCEP becomes the key energy sector reference for the CIDP 4 planning process. In this context, the KCEP will be reassessed by its progress and additional interventions and investment projects will be incorporated as needed.



1.7 County Overview and Energy Profile

1.7.1 Position and Size

Figure 1: Map Showing Sub-Counties in Kilifi County



Source: (County Government of Kilifi, 2018)

Kilifi County is one of the six counties in the Coast region of Kenya. The County lies between latitudes 2° 20' and 4° 0' south and between longitudes 39° 05' and 40° 14' East. It borders Kwale County to the South West, Taita Taveta County to the West, Tana River County to the North, Mombasa County to the South, and the Indian Ocean to the East as indicated in Figure 1. The county covers an area of 12,370.8 km².

1.7.2 Topographic Features

Kilifi County has four major topographic features: **the narrow belt, the foot plateau, the coastal range, and the Nyika Plateau**. The county experiences a bimodal rainfall pattern with an average annual precipitation ranging between 300 mm and 1,300 mm. The annual temperatures range between 21 °C and 30 °C in the coastal belt and between 30 °C and 34 °C in the hinterland.

1.7.3 Ecological Conditions

The county is divided into five Agro-Ecological Zones (AEZs) defining areas with similar production-related characteristics such as annual mean temperatures, vegetation, and humidity. These zones include:

1. **Coconut–Cassava Zone:** This zone covers the coastal uplands and the low-level coastal plains and has the county’s highest potential for crop production. The major farming activities in this area includes fruit tree cropping (mango, citrus, cashew nut and coconut), vegetable farming (chili, brinjals, okra) and food cropping (maize, bananas, cowpeas, upland rice, green grams). Dairy farming also does well in this zone. The zone receives an average annual precipitation of 1,300mm per annum and a mean annual temperature of 24 °C.
2. **Cashew nut–Coconut zone:** this zone stretches northwards along the coastal plain up to the Arabuko Sokoke forest. The zone receives an average precipitation of 900mm and mean annual temperature of 24 °C. It has agricultural potential with the same crop types as the coconut-cassava zone but with slightly less production.
3. **Livestock–Millet Zone:** The zone is of lower agricultural potential with annual precipitation ranging from 700 mm to 900 mm. The area is suitable for dry land farming supporting drought tolerant crops and ranching activities.
4. **Lowland Ranching:** This zone varies in altitude from 90 m to 300 m with annual mean temperature of 27 °C and annual precipitation of 350 mm to 700 mm. The major activities within this zone are ranching and wildlife.
5. **Coconut Cashew Nut–Cassava Zone:** The smallest zone, similar potential for crops as the first two zones.
5. **Coconut Cashew Nut–Cassava Zone:** this zone is mainly found in Kilifi South and North constituencies and is the smallest of all the zones. It lies at an altitude between 30 m to 310 m above mean sea level with mean temperature of 27 °C and annual precipitation of 900 mm per annum. The area has a similar potential for crops as the first two zones.

1.7.4 Administrative and Political Units

Kilifi County has seven sub-counties: Kilifi North, Kilifi South, Ganze, Malindi, Magarini, Kaloleni, and Rabai. The county has 17 divisions, 54 locations, and 165 sub-locations as shown in Table 2. Magarini Sub-county is the largest while Rabai is the smallest in terms of area in km².



1.7.4.1 Administrative units (Sub-County, Divisions, Location and sub-locations)

Table 2: Kilifi County Administrative Units by Area

Sub-County	Area (km ²)	No. of Divisions	No. of Locations	No. of Sub-locations
Kilifi North	264.30	1	6	22
Kilifi South	483.00	2	6	16
Ganze	3,399	4	16	48
Malindi	2,263	2	8	18
Magarini	5,229	2	8	28
Kaloleni	706	5	11	21
Rabai	208	3	7	12
Total	12,552.3	19	62	165

Source (Government of Kenya, KNBS, 2019)

1.7.4.2 Political Units (Constituencies, electoral Wards)

Kilifi County has seven constituencies and thirty-five county wards which are in line with the Kenyan Constitution 2010 as shown indicated in Table 3.

Table 3: County's Electoral Wards by Constituency

Constituency	Area (in km ²)	No. of Wards	No. of Villages
Kilifi North	264.30	Tezo Sokoni Kibarani Dabaso Watamu Matsangoni Mnarani	123
Kilifi South	483.00	Junju Mwarakaya Shimo la Tewa Chasimba Mtepeni	140
Ganze	3,399.00	Ganze Bamba Jaribuni Sokoake	531
Malindi	2,263	Jilore Kakuyuni Ganda Malindi town Shella	305



Constituency	Area (in km ²)	No. of Wards	No. of Villages
Magarini	5,229	Maarafa Magarini Gongoni Adu Garashi Sabaki	457
Kaloleni	706	Mariakani Kayafungo Kaloleni Mwanamwinga	303
Rabai	208	Mwawesa Ruruma Kambe/Ribe Rabai/Kisurutuni	176
Total	12,552.3	34	2035

Source: (Government of Kenya, KNBS, 2019)

1.7.5 Demographic Features

The county is predominantly inhabited by the Mijikenda community but has a representation of all 44 Kenyan tribes and a small population of foreigners (Kilifi County Government, 2018). In 2019, the county's population was 1,453,787, comprising 704,089 males, 749,673 females, and 25 intersex individuals (Government of Kenya, KNBS, 2019). The dependency ratio stands at 101.45%. Table 4 below shows the population distribution across the county:

Table 4: Population Density and Distribution in the County

Sub-County	Area (in km ²)	Population	No. of Households	Density (Persons/(m ²))
Kilifi North	264.30	178,824	39,512	676
Kilifi South	483.00	269,091	64,495	518
Ganze	3,399	166,540	26,737	85
Malindi	2,263	333,226	73,547	147
Magarini	5,229	191,610	33,017	37
Kaloleni	706	193,682	36,355	274
Rabai	208	120,813	24,809	581
Total	12,552.3	1,453,786	298,472	116

Source: (Government of Kenya, KNBS, 2019)

Areas such as Kaloleni, Rabai, and almost the entire stretch of the coastline are densely populated compared to the drier parts of Magarini and Ganze, which are sparsely populated. There is a series of ridges north to south that are found in the mid-section of the County, bounding the high-potential zones to the coastline. Approximately 60% of the population of the County is settled here. The gender structure

reveals the female population being slightly higher than their male counterparts (52% to 48%). The dependent population, those below 15 years and above 64 years, account for 50% of the population. Kilifi County has a child-rich population, where 0–14-year-olds constitute 42% of the total population due to high fertility rates among women, as shown by the highest percentage household size of 7+ members at 36%. The age structure also reflects the national pattern, with those below the age of 30 years being in the ratio of 3:1 compared to the older generation.

A ten-year projection of the population for Kilifi County in 2029 is estimated to be 1,972,819 persons. Table 5 shows the population projections at sub-counties.

Table 5: Population Projections

Sub-County	2019 (Census)			2022 (Projection)	2025 (Projection)	2027 (Projection)
	Normal	Inter-sex	Total	Total	Total	Total
Chonyi	62,334	1	62,335	66,364	70,170	72,730
Ganze	143,902	4	143,906	153,207	161,993	167,904
Kaloleni	193,677	3	193,682	206,200	218,025	225,981
Kauma	22,638	0	22,638	24,101	25,483	26,413
Kilifi North	178,822	2	178,824	190,382	201,300	208,645
Kilifi South	206,749	4	117,713	108,948	232,739	241,232
Magarini	191,610	2	191,610	203,994	215,693	223,564
Malindi	333,217	9	333,226	354,763	375,108	388,796
Rabai	120,813	0	120,813	128,621	135,998	140,960
Total	1,453,762	25	1,453,787	1,547,747	1,636,510	1,696,226

Source: (Government of Kenya, KNBS, 2019)

Table 6: Population distribution and density by Sub-County

Sub-County		Kilifi North	Kilifi South	Malindi	Kaloleni	Magarini	Ganze	Kauma	Chonyi	Rabai
2019 (Census)	Area (in km ²)	264	290	2,263	706	5,229	3,218	181	193	208
	Population	178,824	206,753	333,226	193,682	191,610	143,906	22,638	62,335	120,813
	Density	677	713	147	274	37	129	125	323	581
2022 (Projection)	Area (in km ²)	264	290	2,263	706	5,229	3,218	181	193	208
	Population	190,382	220,116	354,763	206,200	203,994	153,207	24,101	66,364	128,621
	Density	721	759	157	292	39	48	133	344	618
2025 (Projection)	Population	201,300	232,739	375,108	166	215,693	161,993	25,483	70,170	135,998
	Density	763	802	218,025	309	41	50	181	364	654
2027 (Projection)	Population	208,645	241,232	388,796	225,981	223,564	167,904	26,413	72,730	140,960
	Density	790	832	172	320	43	52	146	377	678

Source: (Government of Kenya, KNBS, 2019)



Urban Population

The county's main urban centers include Malindi, Kilifi, Mtwapa, Kaloleni, Mazeras, Mariakani, Watamu, Magarini, Marereni, Majengo, and Bamba. The urban population stands at 338,364, (Government of Kenya, KNBS, 2019), constituting about 23.30% of the total population. Unfortunately, rapid urban growth is taking place without corresponding capacity of the city and town planning and management institutions to guarantee sustainable urban livelihoods. This is evidenced by a myriad of environmental problems including the proliferation of slums, squatter settlements, incessant collapse of buildings, traffic congestion, competing land uses, ribbon pattern of development and urban sprawl. Table 7 shows the population projections for the urban centres in the county.

The population for Malindi (125,706) is much higher than the population for other urban centres in Kilifi County. Population projections for the planning period should therefore guide in resource allocation which will assist in urban planning and resource distribution.

Table 7: Population Projection for Urban Centres in Kilifi County

Urban Area	2019 (Census)	2022 (Projection)	2025 (Projection)	2027 (Projection)
Mtwapa	90,676	95,102	100,556	104,226
Malindi	119,855	125,706	132,915	137,765
Kilifi	74,269	77,894	82,362	85,367
Watamu	27,857	29,217	30,892	32,020
Mariakani	31,715	33,263	35,171	36,454
Vipingo	12,183	12,778	13,510	14,003
Mazeras	16,254	17,047	18,025	18,683
Gongoni	10,993	11,530	12,191	12,636
Marereni	7,085	7,431	7,857	8,144
Kaloleni	7,016	7,358	7,780	8,064
Bamba	2,015	2,113	2,235	2,316
Total	399,918	419,439	443,494	459,677

Source: (Government of Kenya, KNBS, 2019)

Population of Persons with Disabilities

Table 8 presents the population of persons with disability by Type, Age, and Sex. The table shows that in Kilifi County, Mobility (Physical) type of disability is leading with 7,746 persons, closely followed by Visual (6,353). The least common type is speech (Communication), with 3,274 persons.

Table 8: Population of Persons with Disability by Type, Age and Sex

	Age 5+ (ALL)	5–14	15–24	25–34	35–54	55+
	Total	Total	Total	Total	Total	Total
Visual	6,353	585	630	500	1,340	3,298
Hearing	3,569	737	609	403	513	1,307
Mobility	7,746	829	646	507	1,287	4,477
Self-care	3,647	1,125	542	298	364	1,318
Cognition	4,075	764	733	520	688	1,370
Communicating	3,274	1,116	822	490	407	439
Total	28,664	5,156	3,982	2,718	4,599	12,209

Source: (Government of Kenya, KNBS, 2019)

Human Settlement Structure

The human settlement Structure of Kilifi County is influenced by the proximity to infrastructure networks (roads, water, and electricity) and high agricultural potential zones. A linear settlement pattern is found from Mtwapa to Kinangoni along the Mombasa–Malindi road via Kilifi town and Mombasa–Nairobi up to Mariakani urban town. Table 9 describes the classification of urban centres within Kilifi County. This CEP takes into considering the electrification of these settlement centres.

Table 9: Classification of centres in Kilifi County

Principle Towns	Urban Centres	Rural Centres	Market Centres	Local Centres
Malindi	Watamu	Mambrui	Bamba	Kakayuni
Kilifi	Ganze	Gongoni	Tsangasini	Kakuneni
Mtwapa	Rabai	Marereni	Ganda	Lango Baya
Mariakani	Gede	Maarafa	Chakama	Ramanda
Mazeras			Adu	Ngomevi
Kaloleni				Shakahola
				Chakama

Source: (Kilifi County Government, 2022)

1.7.6 County Economy

1.7.6.1 Macroeconomic Context

There are various economic activities in the county, which affect the environment and they include:

- Agriculture
- Manufacturing



- Tourism and sports
- Wholesale and retail trade
- Construction

a) Agriculture

Crop farming remains the primary economic activity. The most cultivated crop is coconut. In high potential zones, the level of crop farming is intense in areas around, Kaloleni, Rabai, Chonyi and along the coastline south of Malindi town. The farming is still largely for subsistence purposes while a few large-scale farming is done by mostly companies. Agriculture is also practiced and the County is known for Sisal and Cashew nuts growing. Agro-based industries are also present making use of the fertile arable lands.

The main crops grown for subsistence are maize, cowpeas, green grams and cassava. The major cash crops in the county include coconut, cashew nuts, pineapples, sisal, and mangoes. The acreage under food crops and cash crops are 52,519.4 ha and 47,681 ha respectively (Kilifi County Government, 2013). The county arable land is estimated to be approximately 6,891.2 km² with a non-arable land of 5,407. This indicates that 56 percent of the land is useful for agriculture while 44 percent could be made useful through irrigation and this would help achieve and SDG numbers one and two, eradication of extreme poverty and hunger by 2030.

Food crop farming is practiced in all parts of the county but cash crop farming is practiced in Kilifi South, Kilifi North, Malindi, Kaloleni, Rabai and Magarini constituencies. The average farm size for most of the county's households is 3.04 ha for small scale farms and 8.09 ha for large scale farming activities.

Livestock farming is also significant economic activity in the county providing income and food to the residents in the hinterlands of Ganze, Langobaya and Magarini. The main types of livestock in the county include cattle, sheep, goats and poultry. The County Government has put in place a programme for upgrading of local livestock breeds to increase productivity (County Government of Kilifi, 2018). The county has 12 branches with a land carrying capacity of 3 livestock per hectare in dairy zones and 0.25 livestock per hectare in the rangelands. The ranches include: Biryia, Ndigeria/Mapotea, Mnangoni, Dola, Chakama, Kiski, Weru and Kilifi among others.

Fishing is the main economic activity in Kilifi due to its proximity to the Indian Ocean. Fishing is an important economic activity that provides employment to the communities along the coastline and creeks with over 5,085 families depending on fishing for survival with an annual catch of about 443.689 tonnes. The county has not exploited fully the available market as an outlet for the locally produced goods. Large quantities of fish are lost as a result of lack of proper storage and handling. There are only 185 stocked fish ponds in the county which covers an area of 222,300 metres square. Trade is another component of economic livelihood of the communities of the County. The growth of urban settlements in the County has not only increase the trading activities but also the sophistication of the level and type of trade.



b) Mining

Kilifi County is rich in minerals such as titanium, iron ore, barites, galena, rubies, pozzolana, gypsum, limestone, manganese, coral rock, silica and salt. Other natural resources in the County with potential for exploitation include Iron Ore, Titanium, oil and manganese (Chasimba). Kilifi County has 10 times more titanium than Kwale has, in Mamburi area. Kilifi has approximately 1.4 billion tones of titanium according to Base Titanium. The Vipingo, Mamburi and Sokoke area that has titanium deposits covers 450.7 kilometres in total.

Most of these minerals still remain unexploited due to inadequate knowledge on their status, economic viability and appropriate mining technologies. Already, an appropriate national mineral prospecting and mining policy conducive to investment and Private Public Partnerships (PPP) in the mining sector is in place. This will facilitate exploitation of the existing opportunities in mineral exploration, mining and value addition through direct or joint venture partnerships.

The on-going mining activities in the county include cement production in Rabai and Vipingo, Salt extraction in Kongoni and Marereni and sand harvesting and quarrying in the entire county.

c) Tourism

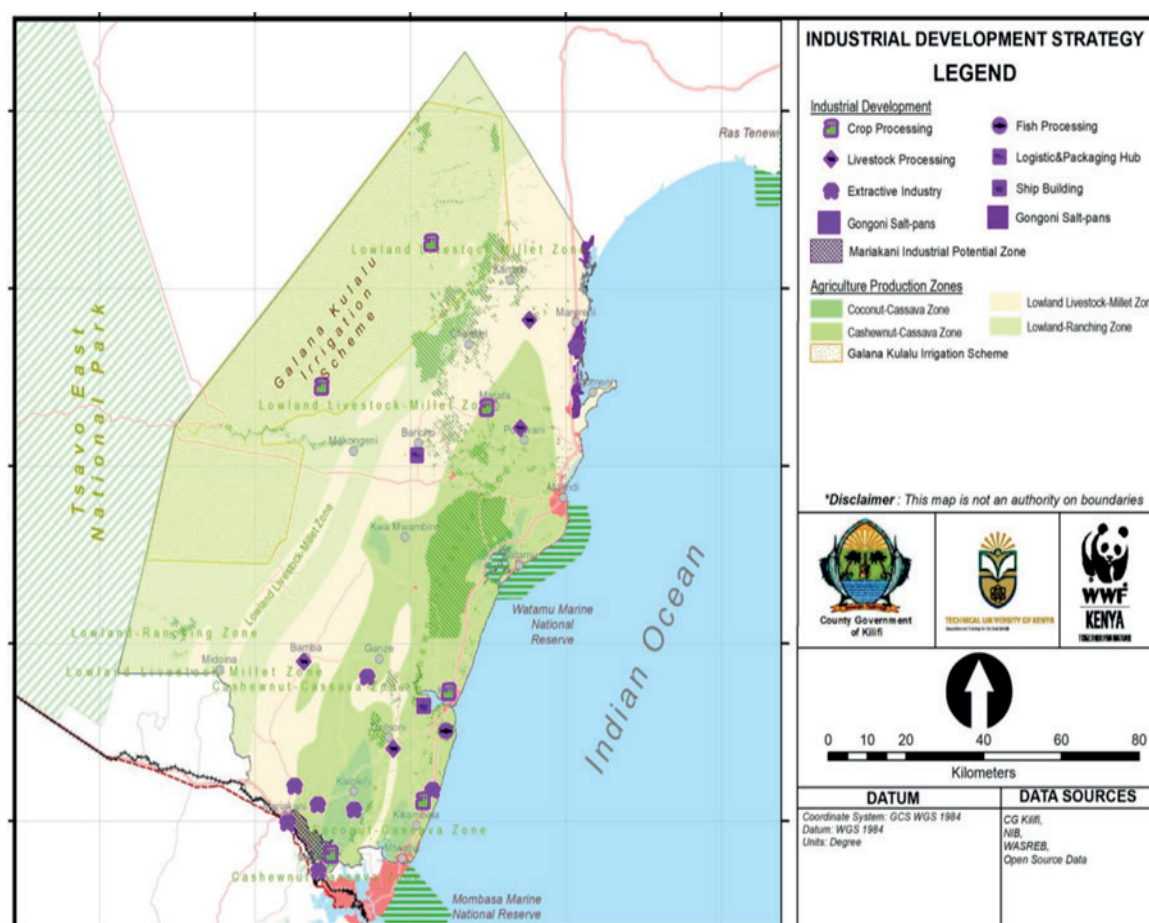
Tourism is vital to the county's economy, with attractions such as wildlife sanctuaries, marine parks, sandy beaches, and historical sites. The county is endowed with many tourism attractions sites which includes; white sandy beaches in Malindi, Watamu, Kilifi and Mtwapa. Historical sites in Gede, Malindi, Takaungu, Mnarani and Rabai that date back to the slave trade period. Other tourist sites include Kaya forests, Marafa Hell kitchen, Bore Valley, Mekatilili Wa Menza, Kapangani Rock and Sabaki Estuary in Magarini and mangrove swamps that attract both local and international tourists. The county provides good opportunities for sport fishing and marine research especially for rare breeding grounds of special fish like Tewa. The county also has the Arabuko Sokoke Forest reserve, Malindi Marine National Park, Watamu Marine National Reserve and Kuruwitu Marine area as major attractions. The Vipingo Ridge golf course and Malindi airport and Kijipwa airstrip are key components of tourism sub-sector.

d) Industry

The county has 25 manufacturing industries which include soft drink manufacturing industries in Mtwapa, Salt manufacturing industries in Gongoni and Marereni, Cement manufacturing industries in Rabai and Vipingo and Steel manufacturing industries in Mazeras and Mariakani among others. Figure 2 shows the map of the industrial development strategy. The map will guide the County Government in planning for energy development in the identified locations.



Figure 2: Map of Industrial Development Strategy

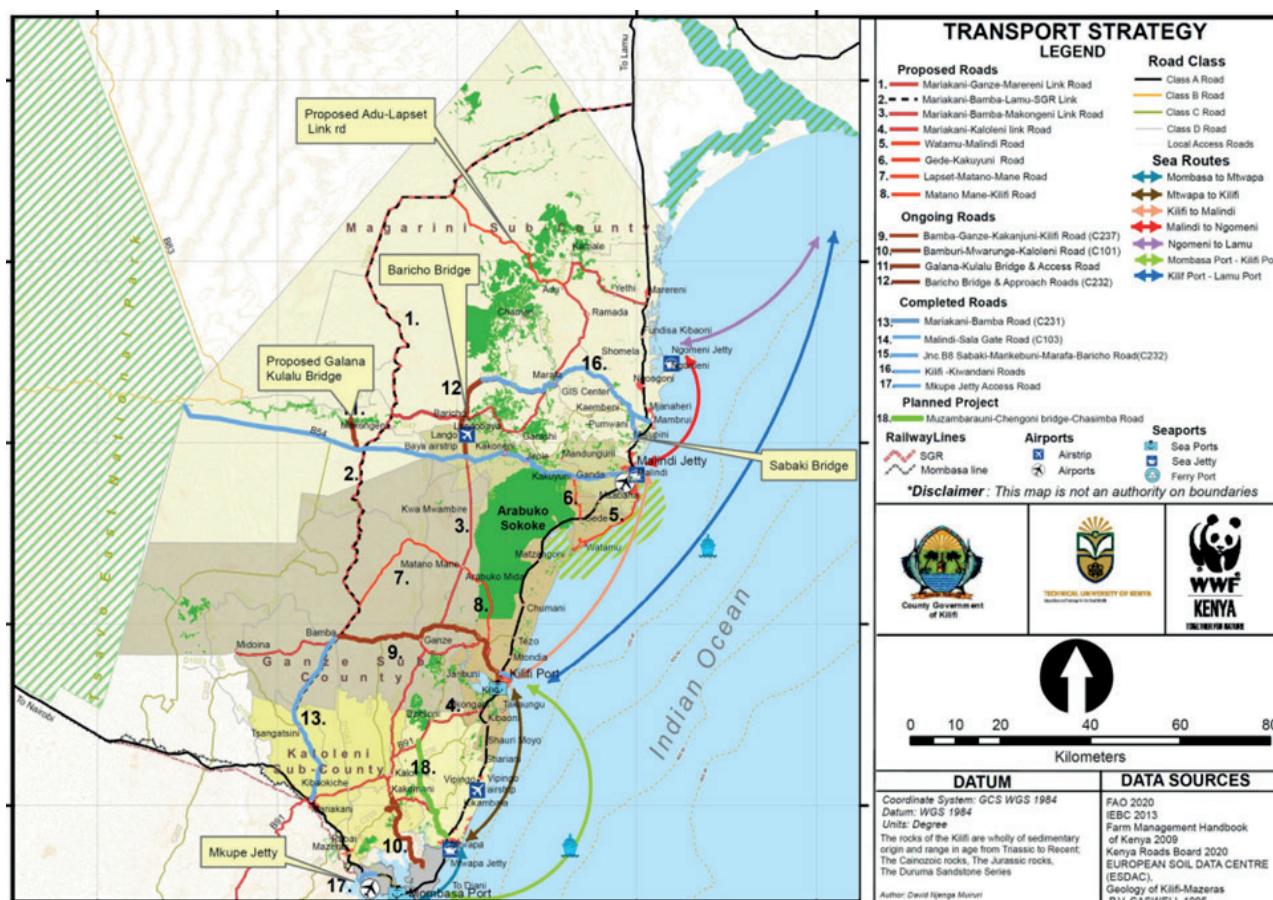


Source: (Kilifi County Government, 2022)

Transport and communication strategy

This strategy focuses on developing transport and infrastructural services to support industrialization. It also focuses on opening up the interior part of Kilifi, to decongest Mombasa–Lamu corridor and to open up more industrial, tourism and agricultural activities in the County so as to increase the vibrancy of the economy. The road linkages will also lead to development of more urban centres along the way. There is also need for establishing an airport in Langobaya to make transportation of Agricultural and livestock produce efficient. The Standard Gauge Railway (SGR) would make transportation of heavy industrial products to the market fast and efficient reducing the transportation cost. Figure 3 shows the planned the transport and telecommunication corridor for Kilifi County. This CEP takes into considering the electrification of these corridors.

Figure 3: Strategies for the Transport Sector.



Source: (Kilifi County Government, 2022)

1.7.7 Community Organizations/Non – State Actors

Community organisations/Non – State Actors play a critical role in mobilisation of communities and provide platforms of awareness creation and resource mobilisation.

1.7.7.1 Cooperative Societies

There are 160 cooperative societies in the county of which 77 are active and 83 are dormant. Out of those who are dormant, 66 have been recommended for liquidation. The cooperatives movement in the county is generally weak with 50 percent of the cooperative societies being either dormant or under liquidation. The weak co-operative sector has made it difficult for farmers to adequately market their produce especially in the crops and livestock sub-sector. The most active co-operative societies are the urban SACCOs and Handicrafts SACCOs. They include Lengo, Malindi Farmers SACCO, Malindi Handcraft Cooperative Society, Turtle Bay, Mariakani, Mbatia, San Marco, and Imarika SACCO. There is great potential in strengthening crops, livestock and fisheries co-operative societies.

1.7.7.2 Non-Government Organizations

The county has a number of Non-governmental partners such as Plan International that focuses mainly on girl child care and education, World Vision in water and sanitation, Education and livelihood, African Medical and Research Foundation (AMREF) in health and education, AIDS, Population and Health Integrated Assistance (APHIAplus) in health matters, Action Aid in water provision and education, Act Kenya, Nature Kenya, Komaza and Moving The Goal Posts in girl child care and international agencies such as United Nations Children's Fund (UNICEF), Kenya Islamic Relief, United Nations Development Programme (UNDP), and World Food Programme (WFP) complementing government development efforts. It should also be acknowledged that faith-based organisations such as Catholic, Justice Peace commission; Anglican Support Services and SupKem amongst others have contributed to the development in the county.

1.7.7.3 Self Help, Women & Youth Groups

The county has a total of 5,921 active community groups of which 1726 are women groups, 3568 are self-help groups and 627 youth groups carrying out various activities such as poultry, retail shops, fishing and small scale farming. There are also youth groups engaged in the music, theatre and advocacy on HIV/AIDS. The National Government is implementing various programmes aimed at empowering and giving social protection to the vulnerable segments of the population. These programmes include Youth Enterprise Development Fund, Women Enterprise Fund, cash transfer for older persons, Orphans and Vulnerable Children (OVCs), and those with severe disabilities.

1.8 Policy, Regulatory and Institutional Framework

The enabling environment for County Energy Planning is anchored in the **Constitution of Kenya, 2010**. Sustainable development is also one of the national values and principles of governance that all state organs, state officers, public officers, and all persons are required to observe as stipulated under Article 10 (2)(d), requiring environmental sustainability in County Energy Planning. Moreover, Article 60 (c) mandates sustainable and productive management of land resources, which includes energy.

1.8.1 Key Legal Documents

1.8.1.1 Constitution of Kenya, 2010

The Constitution enhances the protection and enforcement of fundamental rights amongst other gains. It provides for a two-tier structure of government: national and county. It distributes functions and powers between the two levels in Chapter Eleven and the Fourth Schedule.

Part 1 outlines national responsibility for:

- a) protection of the environment and natural resources with a view to establishing a durable and sustainable system of development including water protection, securing sufficient residual water, hydraulic engineering and the safety of dams;
- b) energy policy, including electricity and gas reticulation and energy regulation and
- c) public investment.



In relation to the energy sector, Part 2 places planning and development responsibilities, including electricity and gas reticulation and energy regulation, with county governments.

Part 1 of the Fourth Schedule provides that the national government shall be responsible

1.8.1.2 The Energy Act, 2019

The Energy Act 2019 revised the 2006 version to align with the 2010 Constitution's introduction of the two levels of governance, the National Government and the County Governments. It consolidates laws related to energy and clarifies the specific roles of the national and county governments.

1.8.1.3 Public Private Partnerships Act, 2013

Under the PPP Act, a contracting authority that intends to finance, operate, equip or maintain an infrastructure facility or provide a service may enter into a project agreement with any qualified private party for the financing, construction, operation, equipping or maintenance of the infrastructure or development facility or provision of the service of the government in accordance with the provisions of this Act. A contracting authority shall, prior to entering into public-private partnership arrangements, pursuant to section 19, undertake a sector diagnostic study and assessment covering the following:

- a) Technical issues;
- b) Legal, regulatory and technical frameworks;
- c) Institutional and capacity status;
- d) Commercial, financial and economic issues and
- e) Such other issues as the Cabinet Secretary may stipulate.

Part VI under project identification and selection of private party, the PPP Act is very clear that all procurement must be through a competitive bidding process. "Except as otherwise provided for under this Act, all projects shall be procured through a competitive bidding process." In procuring and awarding a contract to a private party under this Act, counties must be guided by the principles of transparency, free and fair competition and equal opportunity in accordance with the guidelines made under this Act.

1.8.1.4 The County Governments Act, 2012

This Act requires county governments to integrate economic, physical, social, environmental, and spatial planning, aligning national and county government policies. Environment and climate change functions require concurrent jurisdiction across both levels.

1.8.1.5 The Petroleum Act No. 2 of 2019

This Act of Parliament provides a framework for contracting, exploration, development, and production of petroleum, addressing upstream, midstream, and downstream operations in accordance with the Constitution.



1.8.1.6 Strategic and Planning Documents

1. Kenya Vision 2030
2. County Integrated Development Plans
3. Kenya Sustainable Energy for All (SEforALL)
4. National Climate Change Action Plan (NCCAP)

1.8.2 Institutional Framework

1.8.2.1 National Institutions

Under the third schedule of the Energy Act 2019, key energy sector entities include:

1. **Ministry of Energy and Petroleum:** Develops and implement policies for a conducive energy sector environment for efficient operation and growth of Kenya's energy sector and sets strategic direction to facilitate the growth of the sector while providing long-term vision for all sector players.
2. **State Department of Petroleum:** Focuses on petroleum policies, legal and regulatory frameworks to attract investments in the country's petroleum sector.
 - National Oil Corporation of Kenya (NOCK);
 - Kenya Pipeline Company (KPC); and
 - Kenya Petroleum Refineries Limited (KPRL).
3. **Council of Governors (CoG):** Facilitates coordination between county governments on energy planning.
4. **Cross-Cutting Agencies**
 - Kenya Forests Service (KFS)
 - Kenya Forestry Research Institute (KEFRI)
 - Ministry of Agriculture

1.8.2.2 Inter-County Level Coordination Structure

Some programmes, projects and initiatives may cut across several counties. Counties are organised into 7 regional economic blocks. Counties within an economic block may engage and consult on common energy matters as appropriate. In addition, any county government or block may engage and consult with another on common areas of interest.

1.8.2.3 County Government Energy Coordination

Counties are advised to establish county energy coordination structures best suited to their needs. This will ensure that County Directors of Energy, County officers for Energy and CECMs responsible for Energy are fully aware of and informed about all energy activities being implemented in the county. It will also ensure that all resource and investments are aligned to country priorities and are well-coordinated and harmonised. For effective and efficient coordination of energy planning at the County level there



is need for the counties to establish fully fledged energy departments, directorates or units. The County Governments shall: -

- a) Coordinate the development of CEP and thereafter submit the same to the CEPC for approval.
- b) Coordinate the review and update of the CEP every three (3) years while ensuring that each update takes into consideration changes in the economy, demography, technologies, and the global trends.
- c) Collect, collate and analyse data and information relevant for energy planning.
- d) Provide guidance on coordination and responsibilities on data collection, format, collation, analysis management, storage and sharing to support INEP at the national and county level.
- e) Develop guidance on coordination and roles/responsibilities on data access from non-energy datasets providers like KNBS, KFS
- f) Undertake short-term and long-term forecasting, simulations and optimization of energy projects using appropriate tools.
- g) Consolidate the list of committed projects and their implementation time frames.
- h) Develop screening mechanisms for their county energy projects identification based on least cost principles.
- i) Undertake monitoring and evaluation of the implementation of the CEP, and prepare and submit the progress report to the CEPC for publishing within three months after the end of each financial year.
- j) Collaborate with the Energy Planning and Coordination Unit at national level to develop a framework to guide the selection of the appropriate technology to meet energy demand.
- k) Provide technical data, statistics, and information to policy makers in the energy sector as may be appropriate from time to time.
- l) Initiate research in consultation with the relevant Agency to inform policy and decision making at the county level.
- m) Strengthen linkages and synergy with other sectors of the economy both at national and county level.
- n) Identify and propose capacity building areas relevant to energy planning in the county.
- o) Undertake any other tasks that may be assigned by the Chief Officer responsible for energy.
- p) May where necessary, identify and recommend to the Chief Officer for co-option, up to a maximum of five (5) members with specific technical skills necessary for the discharge of the CEPC mandate.

1.8.2.3.1 County Energy Planning Committee (CEPC)

The establishment and mandate of this committee is contained in article 7 of the draft Energy (INEP) Regulations, 2021. According to this article, the Governor is responsible for establishing the committee. The Committee is made up of the Executive Committee and the Technical Committee. The CEPC shall;

- a) Prepare and submit the CEP in respect of its energy requirements to the Governor for approval and onward submission to the Cabinet Secretary for incorporation into the INEP;



- b) Prepare and submit an annual report on the implementation of the CEP to the Governor for approval and onward submission to the Cabinet Secretary;
- c) Undertake monitoring, evaluation and reporting on county energy plans; d. Undertake a review of the CEP after every Three (3) years; and
- d) Identify, propose and facilitate capacity-building areas relevant to energy planning.
- e) Identify potential financing and funding sources.

1.8.2.4 Kilifi County regulations

- 1. Forest Management and Conservation Act of 2021,
- 2. Climate Change Act 2021,
- 3. Solid waste management Act of 2019 and Environmental Management and Coordination Act (EMCA) for Kilifi County.

1.8.3 Actors In Implementation of the Integrated National Energy Plan (INEP)

1.8.3.1 Ministry of Energy and Petroleum

- a. Provide overall leadership in planning, administration, implementation, monitoring, evaluation and reporting of INEP.
- b. Organise stakeholder engagements in the preparation of INEP.
- c. Develop, review and publish INEP to guide alignment of investments in the energy sector.
- d. Establish and convene joint annual planning, budgeting, and monitoring processes and forums to ensure all available resources are aligned and reflected in annual plans and budgets.
- e. Provide guidance and reporting formats to sector partners to report on planned investments at national and county levels.
- f. Provide information on energy sector requirements and resource gaps to guide prioritisation and harmonisation of inputs from energy stakeholders.
- g. Establish mechanisms for information sharing and harmonisation among energy sector stakeholders.
- h. Establish and maintain a comprehensive information repository and resource mapping and tracking system for the entire energy sector.
- i. Establish and convene joint annual review processes and forums involving all sector partners.
- j. Develop Energy Sector Monitoring, Evaluation and Reporting (MER) framework
- k. Provide frameworks and opportunities for active stakeholder engagement.
- l. Identify areas where capacity strengthening is required to achieve sector and partnership objectives.
- m. Provide an Energy Planning Online Platform for use in INEP, CEP and National Energy Service Providers plans.
- n. Develop adequate policy, regulatory and institutional frameworks for successful implementation of INEP.



1.8.3.2 National Energy Service Providers

The National Energy Service Providers include the MoEP (SDE), EPRA, KPLC, KenGen, REREC, KETRACO, Geothermal Development Company (GDC) and Nuclear Power and Energy Agency (NuPEA). Under this heading, MoEP's role as a national energy service provider is limited to licensing of geothermal and downstream coal.

- a. Provide overall leadership in planning, administration, implementation, monitoring, evaluation and reporting of their respective Energy Plan
- b. Submit their energy plans to Cabinet Secretary for incorporation into INEP.
- c. Organise stakeholder engagements in the preparation of their energy plans.
- d. Provide resources for implementation of energy plans relevant to their mandate.
- e. Build the energy planning capacity of their staff.
- f. Monitor and report on the progress of the implementation of their energy plans relevant to their mandate.
- g. Collaborate with County Governments and other stakeholders during planning, and implementation *of energy projects*

1.8.3.3 Other National Government Ministries, Departments, and Agencies (MDAs)

These entities:-

- a. Propose interventions in the INEP.
- b. Provide resources for implementation of interventions relevant to their mandate.
- c. Monitor and report on the progress of the implementation of INEP relevant to their mandate.

1.8.3.4 Council of Governors

- a. Coordinates all the 47 county governments in the preparation of energy plans.
- b. Coordinate capacity-building for county governments in energy planning.

1.8.3.5 Development Partners

These partners:-

- a. Support and collaborate with the Government to achieve Kenya's energy agenda.
- b. Provide technical and financial support to the Ministry to implement INEP.
- c. Ensure their programmes and plans are aligned to energy sector plans and priorities at national and county levels.
- d. Provide requested information to inform planning, budgeting and review processes at national and county levels.
- e. Provide requested technical and financial support to strengthen energy planning at national and county level.
- f. Actively participate in sector coordination processes and forums at national and county levels.



- g. Establish common arrangements among partners for planning, appraisal and review processes.
- h. Develop and monitor mechanisms to simplify procedures for engagement with the Government.
- i. Provide regular reports on support to attainment of sector results.
- j. Actively participate in and contribute to sector forums.
- k. Build the capacity of energy stakeholders to actively engage and participate in sector processes and forums.

1.8.3.6 Private Sector and Non-Governmental Organizations

These players:-

- a. Participate in the preparation and implementation of INEP and CEP.
- b. Support and collaborate with the government to achieve the country energy agenda.
- c. Develop and share plans and reports with government and sector partners.
- d. Ensure their projects and plans are aligned to energy sector plans priorities at national and county levels.
- e. Provide requested information to inform planning, budgeting and review processes at national and county levels.
- f. Actively participate in sector coordination processes and forums at national and county levels.
- g. Provide regular reports on support to attainment of sector results.
- h. Share information on programmes and support being provided, to guide each other's prioritisation of support.
- i. Actively participate in and contribute to sector forums.
- j. Build the capacity of non-state actors to actively engage and participate in sector processes and forums.



Chapter 2: ENERGY RESOURCES

The county is endowed with immense energy resources. These include biomass, solar, wind, municipal waste, tidal energy, and petroleum deposits. The exploitation and development of energy resources are, therefore, key policy focuses for the county, both in the short, medium, and long term.

2.1 Bioenergy Resources

Bioenergy is organic matter used to provide heat, make fuel, and generate electricity. It exists in three forms: solid (biomass), liquid (biofuels), and gaseous (biogas). Bioenergy is considered a renewable, potential carbon neutral and sustainable source of energy. Sources of bioenergy include: energy crops, forestry biomass (firewood, charcoal), landfill gas, plant residue, and the organic component of municipal and industrial waste. Its key advantage is its easy storage, which makes it possible to produce and use energy on demand.

2.1.1 Woodfuel

Woodfuel is the largest source of bioenergy and has been used to provide heat for thousands of years. The county's 21 forests cover 246 km², with a forest cover of 7.67% (Kiarie, N., 2016). Kilifi County has an estimated 1,500,000 hectares of forest, out of which 48,000 hectares are gazetted forest reserves, while the rest, are mostly on community lands. The main forests include; Arabuko Sokoke, Mangrove Forest, and Dakatcha woodlands. However, unprecedented forest degradation in recent times, particularly in Dakatcha Woodland and Mwangea Forests, has been experienced. Table 10 shows the forests by type and size in Kilifi County.

Table 10: Forest by Type by Size in Hectares

Forest Name	Forest Type	Tenure	Area (Ha)
Arabuko Sokoke	Natural Forest	Gazetted	41,764
Kaya Forests (25 Kayas)	Natural Forest	Gazetted	1,693.48
Dakatcha Woodland	Woodland	Ungazetted	56,670
Mwangea hills	Natural Forest	Ungazetted	3,500
Mangrove Forest	Natural Forest	Gazetted	6,000
Marafa	Woodland	Gazetted	Unknown
Kisimani kwa Ngowa	Natural Forest	Ungazetted	Unknown
Baricho Forest	Natural Forest	Ungazetted	Unknown
Total Forest (Ha)			84,809

Source: Critical Ecosystem Partnership Fund, 2015

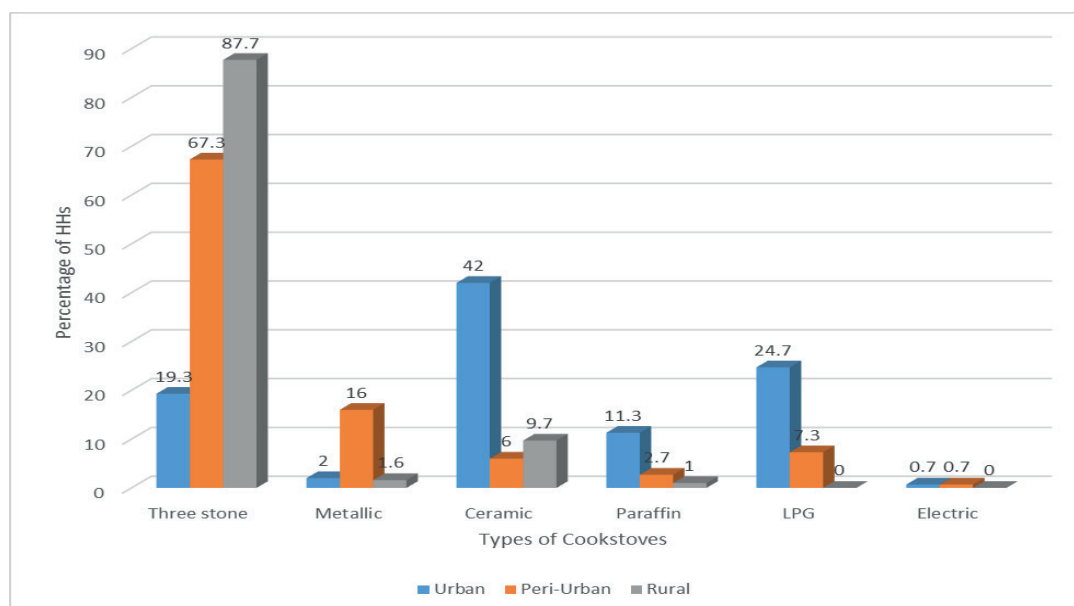


A large proportion—80.1% (58.2% firewood and 21.9% Charcoal)—of the county’s population relies on woodfuel for cooking and heating (Government of Kenya, KNBS, 2019). The forests in the county act as sources of livelihood, supporting the majority of the rural population who depend on them for their energy supplies.

This heavy reliance contributes to deforestation and forest degradation as reserves are depleted faster than they are replenished. Widespread use of traditional energy technologies which are inefficient exacerbate the loss of energy and greenhouse gas emissions, posing serious health hazards as well as compounding the effects of climate change. Efforts such as afforestation and use of improved cookstoves have been implemented by both the government and the private sector to conserve forests resources but with limited success.

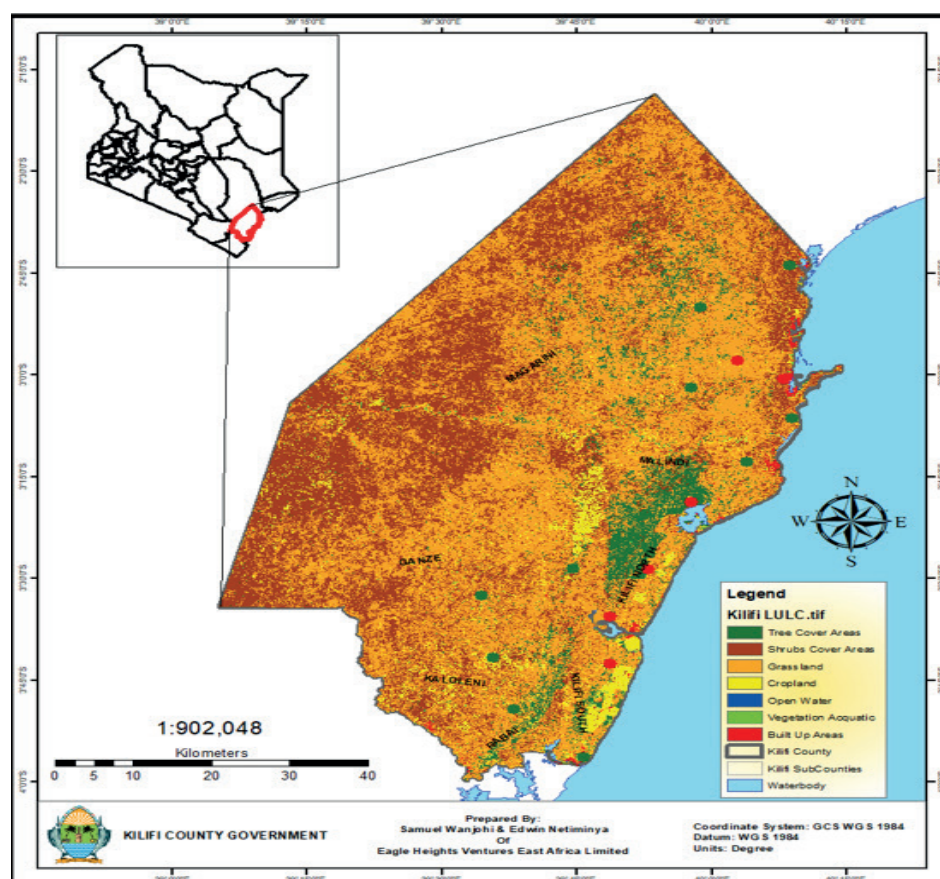
The use of different cooking fuels by households in Kilifi County is as follows: 10.7% Liquefied Petroleum Gas (LPG), 0.5% electricity, 5% paraffin, and 83.8% woodfuel ((firewood 58.1% and charcoal 25.7%) (Kilifi County Govt and GROOTS Kenya, December 2019). In terms of cookstoves, 58.1% use three stone, 6.5% traditional metal jiko, 19.2% ceramic jiko (energy saving jiko), 5% paraffin cookstoves, 10.7% LPG cookstoves and 0.5% use electric cooker. Figure 4 shows the most frequently used cookstoves used by households. Additionally, 64.6% of woodfuel consumers use inefficient cookstoves, with 58.1% using three-stone fires and 6.5% using traditional metallic jiko. The survey indicated that main sources of fuel wood is public forests and private woodlots.

Figure 4: Households’ Access to Various Types of Cookstoves



Source: (GROOTS Kenya, September 2019)

Figure 5: GIS Map of Land Use Land Cover for Kilifi County



Source: (County Government of Kilifi, June 2020)

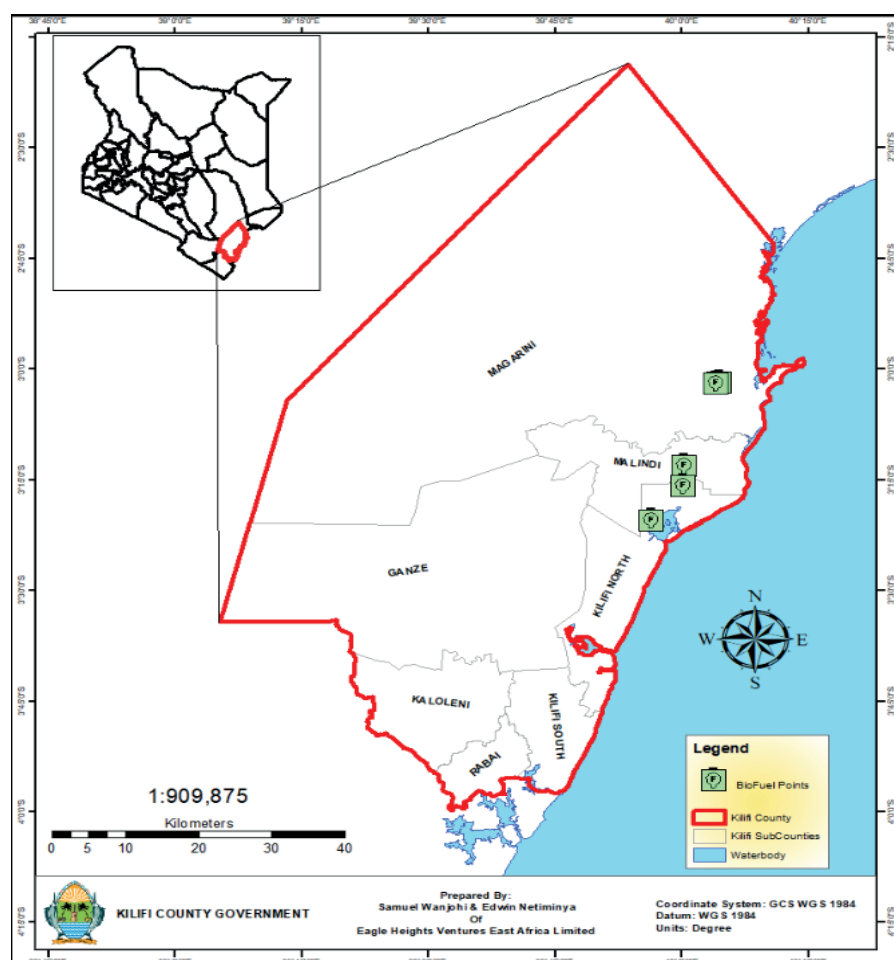
2.1.2 Biofuels

Biofuels, particularly bioethanol and biodiesel, are liquid fuels derived from organic matter and offer an alternative to fossil fuels in the transport sector. While biofuels have existed for longer than cars, their usage has remained limited due to the availability of cheap gasoline and diesel. However, spikes in oil prices and the need to address climate change has renewed interest in biofuels. Our road travel, flights, and shipping account for nearly a quarter of the world's greenhouse gas emissions, and transportation today remains heavily dependent on fossil fuels. The idea behind biofuel is to replace traditional fuels with those made from plant material or other feedstocks that are renewable.

Bioethanol, produced from sugar-containing feedstocks (e.g. sugar cane or sugar beet) or starchy feedstocks (e.g. maize, cassava, sorghum and wheat) that first need to be converted to sugar, are fermented to alcohol. The fermentation process is similar to that used to make wine or beer, and pure bioethanol is obtained by distillation. Bioethanol can be blended with petrol or burned in nearly pure form in slightly modified spark-ignition engines. A litre of ethanol contains approximately two thirds of the energy provided by a litre of petrol. However, when mixed with petrol, it improves the combustion performance and lowers the emissions of carbon monoxide and sulphur oxide.

In Kilifi County, there is potential for biofuel production from Jatropha and Cassava. Jatropha, a biodiesel crop, is grown by smallholder farmers in the following areas; Mida–Majaoni, Mijimboni, Kakuyuni in Malindi and Bomani in Magarini. Cassava is an important food crop in Kilifi County owing to its hardiness though it can also be used as a substrate for production of Bioethanol. Figure 6 shows areas where Jatropha is grown in Kilifi County.

Figure 6: GIS Map of Areas Where Biofuels (Jatropha) is Grown in Kilifi County



Source: (County Government of Kilifi, June 2020)

2.1.3 Biogas Energy Resources

Biogas is produced by the anaerobic (in the absence of oxygen) breakdown of organic matter, consisting primarily of methane and carbon dioxide. Anaerobic digestion is the degradation of organic material by microbial activity in the absence of air transforming it into biomass and biogas, a mixture of methane (CH_4), carbon dioxide (CO_2) and some trace gases. Biogas is a clean household cooking fuel suitable for remote areas where households have no access to any other clean cooking fuel.

Kilifi County's conducive annual temperatures and livestock rearing provide vast biogas potential for biogas production all the year round, particularly from cow dung. Livestock keeping is an important economic activity that supports the livelihoods of many communities in the county. Cattle contributes to 52 percent of household cash income. On average smallholder farmers keep 10 cattle per household (Kilifi County Government, 2018). Biogas production requires temperatures between 20 °C to 35 °C. In Kilifi County the annual temperature ranges between 21 °C and 30 °C in the coastal belt and between 30 °C and 34 °C in the hinterland (Kilifi county Government, 2020). Cattle, sheep, goats and poultry are the major types of livestock kept by subsistence farmers in the county.

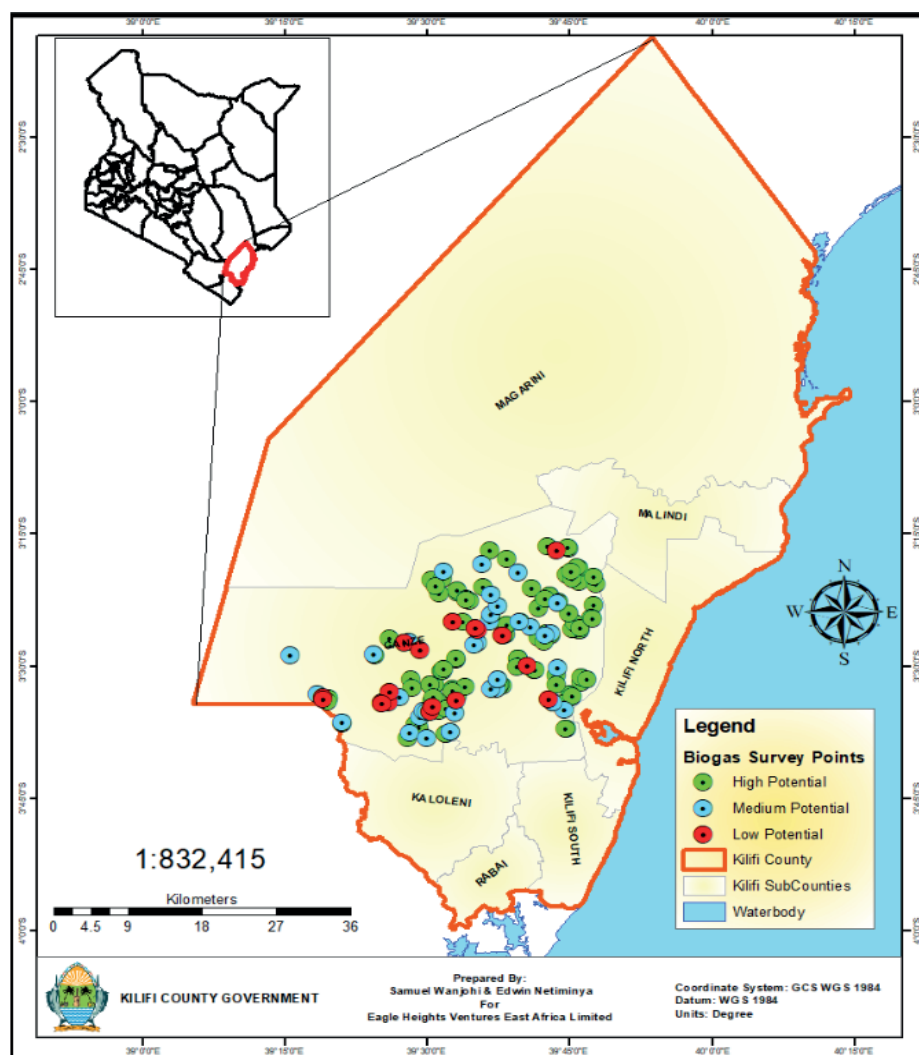
Despite the potential for biogas as a clean cooking fuel, its adoption in the county is low, with severe health, gender, economic, environmental, and climate impacts. Inefficient and dangerous cooking practices lead to deforestation and environmental degradation, while also contributing up to 25% of global black carbon emissions. Promoting the use and increased adoption of clean and efficient cookstoves and fuels will help the world reach its climate and environmental protection objectives, particularly those outlined in Goals 13, 14, and 15 of the Sustainable Development Agenda regarding action on climate change and protecting global ecosystems.

Biogas is a clean cooking fuel. However, its penetration in the County is very low. According to Mtwapa Energy Centre, the number of domestic biogas plant installed in Kilifi less than 100. The Ministry of Energy installed 27 domestic biogas plants in 2017, each with a capacity of 10m³. During monitoring and evaluation, it was found out that 8 of the biogas plants were not working mainly due to challenges related to either inadequate or lack of water or cow dung or both. To avoid such failures, Kilifi County Government intends to develop a Geographic Information System (GIS) database of households which have the potential to install biogas plants. This will be done by undertaking a feasibility of study to establish the technical feasibility of households in the county to adopting biogas technology. A pilot study was conducted in Ganze Sub-county sampling 264 households. Ganze sub-county is 100 % and about 99% of the households use woodfuel for cooking (Kilifi County Govt and GROOTS Kenya, December 2019).

From the households surveyed, 171 (64.7%) of them met the criteria for domestic biogas installation (Kilifi County Government, Department of Energy, March 2020) based on livestock ownership and water availability. The minimum number of cattle required was 10 while the longest time taken to fetch water limited to 1 hr. The result of the study puts the potential of households for installation of biogas plant in rural area stands at 64.7%. Figure 7 shows the GIS Map of households analysed in Ganze Sub-county with potential for installation of domestic biogas.



Figure 7: GIS Map of Potential HHs in Ganze Sub-County for Installation of Biogas Plant



Source: (County Government of Kilifi, June 2020)

2.1.3.1 Potential for Power Generation from Sisal Waste

The county has a 3MW biogas power plant at Kilifi plantation. Approximate fibre production from the three plantations in the county is 7,000t/a

1. Rea Vipingo Plantations Vipingo production estimated at 5,000 t/a
2. Kilifi Plantations Ltd. production estimated 1,000 t/a
3. Tabu Estate Ltd. production estimated 1,000 t/a

Processing one ton of clean and dry sisal fibre generates about 19 tonnes of waste (this is diluted with about 5 tonnes of water from the washing). A biogas production rate of 0.4 m³/kg VS has been observed during Danish Technology Institute (DTI) studies. This corresponds to a typical gas yield of about 54 m³/t of waste. Using typical figures on biogas composition and engine efficiency, this would be sufficient to generate about 1750 kWh per ton of produced fibre. Hence the biogas potential from sisal waste is 7,000t/a x 1750 kWh/t = 12,250 MWh per annum.

Feedstock classification for Technology Value Chains (TVCs)

Biomass feedstocks were assigned to one of eight categories in order to characterise TVCs. The team adapted the classification system of FAO (2004), as summarised in Table 11.

Table 11: System Used for Classifying Biomass Feedstocks for TVC Characterisation

Feedstock Category	Sub-Category	Description	Examples
Woodfuels	Forest and plantation wood	Wood from forests, shrubs and other trees either used directly as fuel or with minimal processing	Eucalyptus, Prosopis spp., rubber tree
	Wood by-products	Wood derived from wood processing for other purposes	Sawmill waste, pine waste, wattle wood
Agro-fuels	Energy crops	Plants or crops grown explicitly or available naturally for the production of biofuels	Bamboo, dhaincha (Sesbania spp.), water hyacinth
	Agricultural byproducts	Mainly by-products from crop harvesting and other agricultural activities left in the field	Rice husk, maize cobs, but shells
	Agro-industrial byproducts	Biomass materials produced chiefly from inedible feedstocks used in food and fibre processing industries	Bagasse, palm oil mill effluent, sisal waste
Others (including mixtures)	Animal byproducts	Waste and by- products from poultry and livestock	Manure, litter, slaughterhouse waste
	Horticultural byproducts	Waste from non-staple plants such as fruits, flowers or ornamentals	Pineapple residues, flower waste
	Municipal by products	Solid and liquid wastes produced directly by humans	Municipal solid waste, sewage sludge, human waste

Source: (Submitted to DFID by LTS International, the University of Edinburgh and E4tech, 20th April 2017)

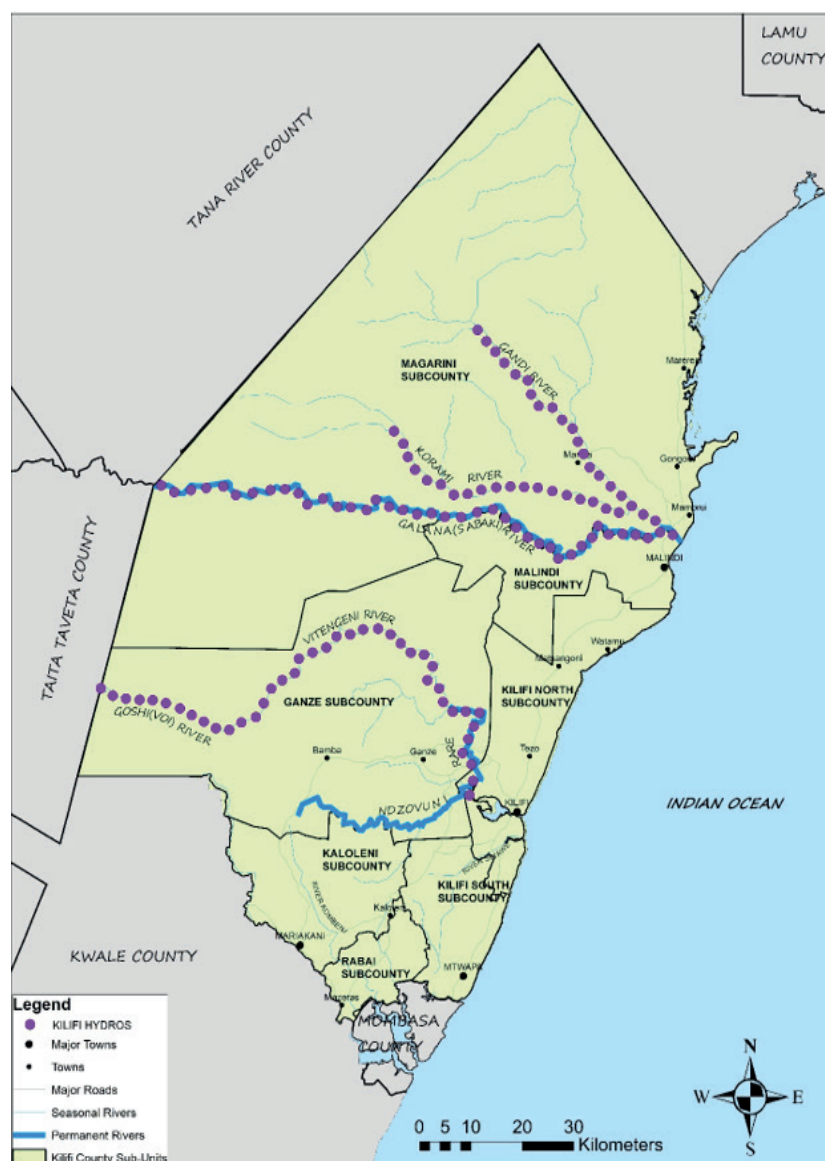
2.1.4 Hydropower Resources

In 2015, the Ministry of Energy developed and established a national database and information retrieval system for national hydropower development. A digital elevation model (DEM) was used in the analysis since it carries all the hydro information needed in the analysis. The rivers were segmented into 3 km hydro reaches in ArcGIS environment. From the analysis Kenya has a total run off the river analysis (i.e. river surface to surface along the river profile) of approximately 5937.25 MWa while Kilifi County has a hydropower potential of 73.317 kWa (73.317 MWa) (Ministry of Energy, June 2015). Run-of-the-river (RoR) power plants, which do not require dams or catchments since they are constructed on the run of the river, are well-suited for these water bodies. Figure 6 shows the GIS map of some of rivers in the County whose hydropower potential has been assessed while Figure 8 shows the unassessed hydropower resources in the County.

The county's drainage pattern consists of one permanent river, the Sabaki, and several seasonal rivers which drain into the Indian Ocean. The seasonal rivers are Nzovuni, Rare, Goshi and Kombeni. The streams include Wimbi, Kanagoni, Masa, Muhomkulu and Mleji. Map 10 Shows the topography of Kilifi County and how it affects drainage.



Figure 8: GIS Map of Small Hydropower Potential in Kilifi County



Source: (County Government of Kilifi, June 2020)

2.2 Solar Energy Resource

According to the Global Solar Atlas¹, the solar potential in Kilifi is significant, particularly in the eastern parts towards the ocean. Figure 10 shows the long-term yearly average Global Horizontal Irradiation (GHI) in Kilifi County with the average GHI being about 1,919 kWh/m²/year. This implies a high potential for photovoltaic (PV) electricity production (see Figure 9).

¹ Global Solar Atlas—<https://globalsolaratlas.info>. Datasets are on long-term yearly average of global horizontal irradiation (GHI) in kWh/m² and potential photovoltaic electricity production (PVOUT) in kWh/kWp, covering the period 1994–2018.

Figure 9: A GIS Map of Solar Energy Resources in Kilifi County

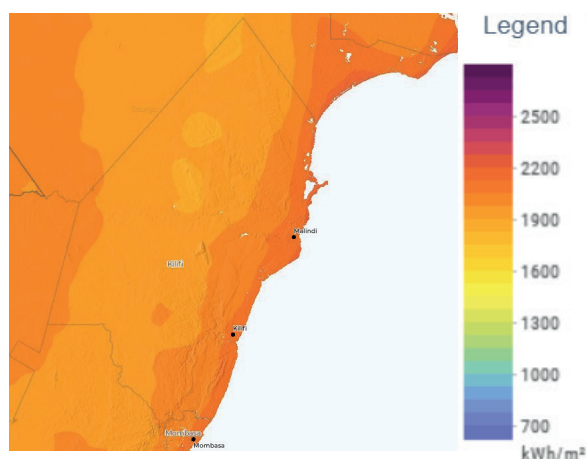
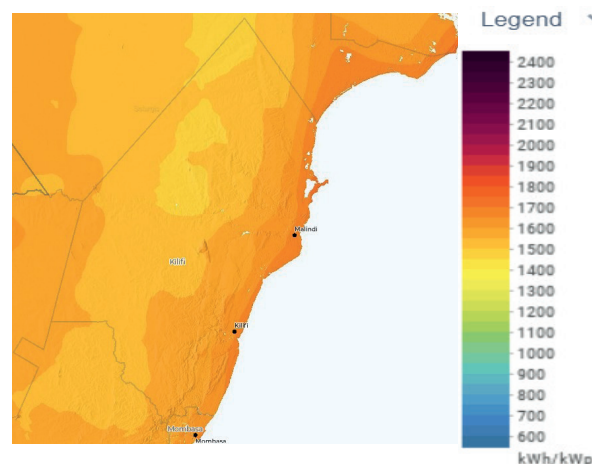


Figure 10: Global Horizontal Irradiation in kWh/m²/day



Regarding solar irradiation, the best resources are in the eastern sides of the county towards the ocean. The GHI is close to 6 kWh/m²/day

The less-endowed county regarding the solar resource is the Northern part of the County with a GHI of 5.173 kWh/m²/day.

The western sides of the county has an average GHI of 5.4 kWh/m²/day.

Zone	Min	Max
Southern	4.23	4.45
Central	4.0	4.2
Northern	4.09	4.5

The photovoltaic (PV) power output is the power produced by the PV panels as a total output.

This does not include the system losses that can be different for the different types of applications of PV technology. Generally, the losses vary from 10–14% for the grid-connected to more than 20% for solar mini-grids supported by battery storage

The average potential PV power output is about 4.14 kWh/kW_p per day.

The county has a solar power plant at Gongoni salt farm with generation capacity of 0.98 MW and a 40 MW Malindi Solar PV plant in Malindi sub-county. The 40 MW Malindi Solar PV plant is owned by an independent power producer (IPP) who sells power to the national grid under Power Purchase Agreement (PPA). The power generated will be sold to the national grid. Figure 8 shows the GIS solar energy Map of Kilifi County.

2.3 Wind Energy Resource

The wind energy can be harnessed using windmills and wind turbines. Wind power is inexhaustible/renewable. Windmills converts wind energy into mechanical power which can be used for in pumping water in ranches or to homes. Wind turbines connected to generators (aero generators) are used to convert



wind energy in to electricity. There are several types of wind turbines for generating electricity. Wind speed increases if wind is funneled into a valley and will also be slightly higher near the ground at the top of a smooth hill. The highest wind speeds are generally found on hill tops, exposed coasts and out at sea. Modern wind turbines vary in size with two market ranges:

- Small units rated at just a few hundred watts up to 50–80 kW in capacity, used mainly for rural and stand-alone systems; and
- Large units, from 150 kW up to 7 MW in capacity, used for large-scale, grid-connected systems.
- Average Wind Speed Sites where the annual average wind speed exceeds 6 m/s at 30 m above ground level are acceptable for wind power development.

However, in established markets, commercial proven utility scale wind turbine capacities (not considering off-shore applications) usually range from 1.5 MW up to 3.5 MW. The small-scale units are mainly used for off-grid applications such as water pumping. Grid-connected wind turbines already have a considerable impact in developed countries and are increasing in some developing countries as well. This is mainly through large-scale installations, either on land (on-shore) or in the sea on the continental shelf (off-shore). Figure 12 shows Kilifi County GIS Map for wind resources

Wind turbines generate electricity intermittently depending on wind speed. Because wind turbines do not produce power constantly and at their rated power (which is only achieved at higher wind speeds), capacity factors are typically between 20% to 55%. One of the principal areas of concerns of wind energy is its variable power output, accommodation of which can be a challenge for the power network as the share of intermittent generation on the grid rises.

A 26 MW wind power plant in Malindi has identified power plant with 2024 as the proposed timelines for construction (Government of Kenya, Ministry of Energy, 2016).

Wind speed is also a crucial factor when deciding the power class wind turbine. A wind turbine that is perfectly designed and constructed will create no output unless it is properly located in an area with sufficient winds. Wind speed is usually measured in metres per second for rating wind turbine locations, which can be easily converted to miles per hour. Table 12 shows power class ratings for wind turbines at a given wind speed.

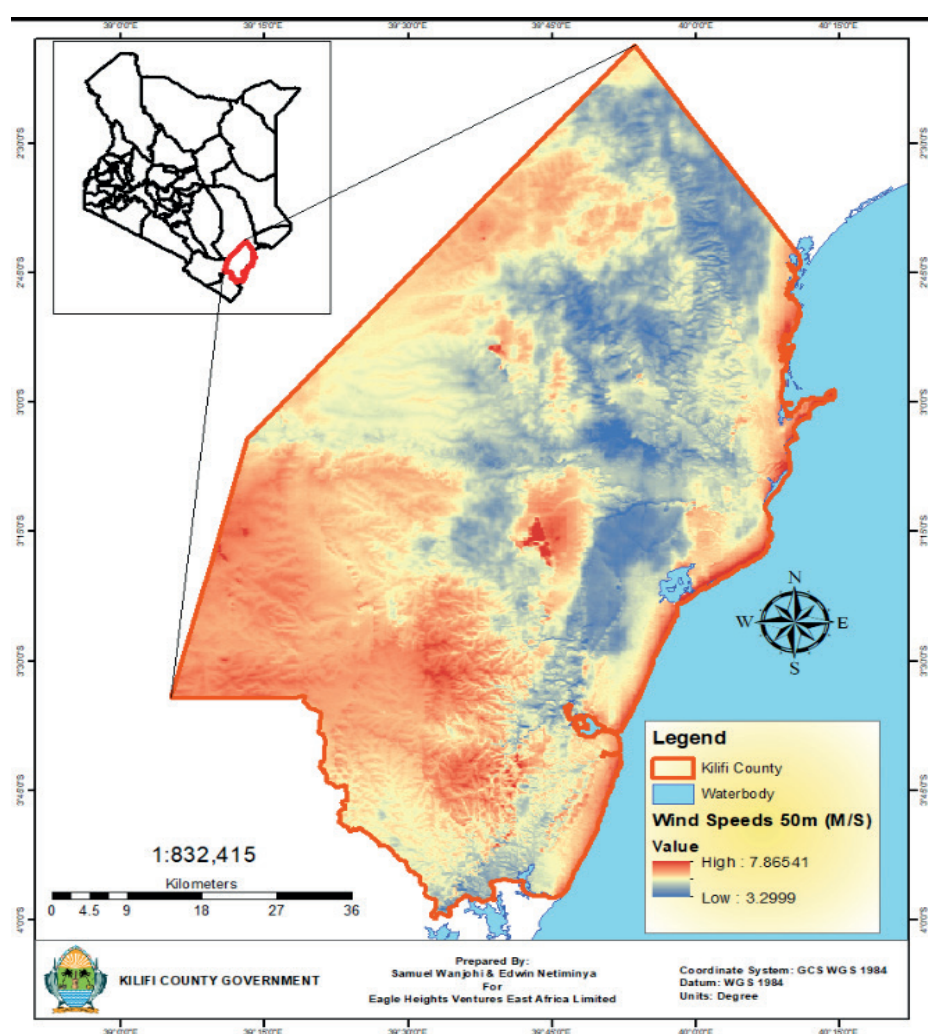
Table 12: Power Class Ratings for Different Wind Speeds

Power Class	Wind Speed in m/s	Quality of the Site
1	4	Not Acceptable
1	5	Poor
2	6	Moderate
3	7	Good
4	7.5	Very Good
5	8	Excellent
6	8.5	Excellent
7	9	Excellent

The county experiences wind speed with an estimated average of 5–7 m/s at 50 m high rendering a potential ground for developing wind energy technologies to support social and economic activities. The county possesses good wind speed with maximum value of mean annual wind speed of 7.8 m/s at a height 50 m as indicated in Figure 9. The coastal strip, significant parts of Ganze, parts of Kaloleni and Magarini have potential sites for commercial investment in wind energy. Therefore, there is significant potential to use wind energy for grid connected wind farms, isolated grids (through wind-diesel hybrid systems) and off-grid community electricity and water pumping.

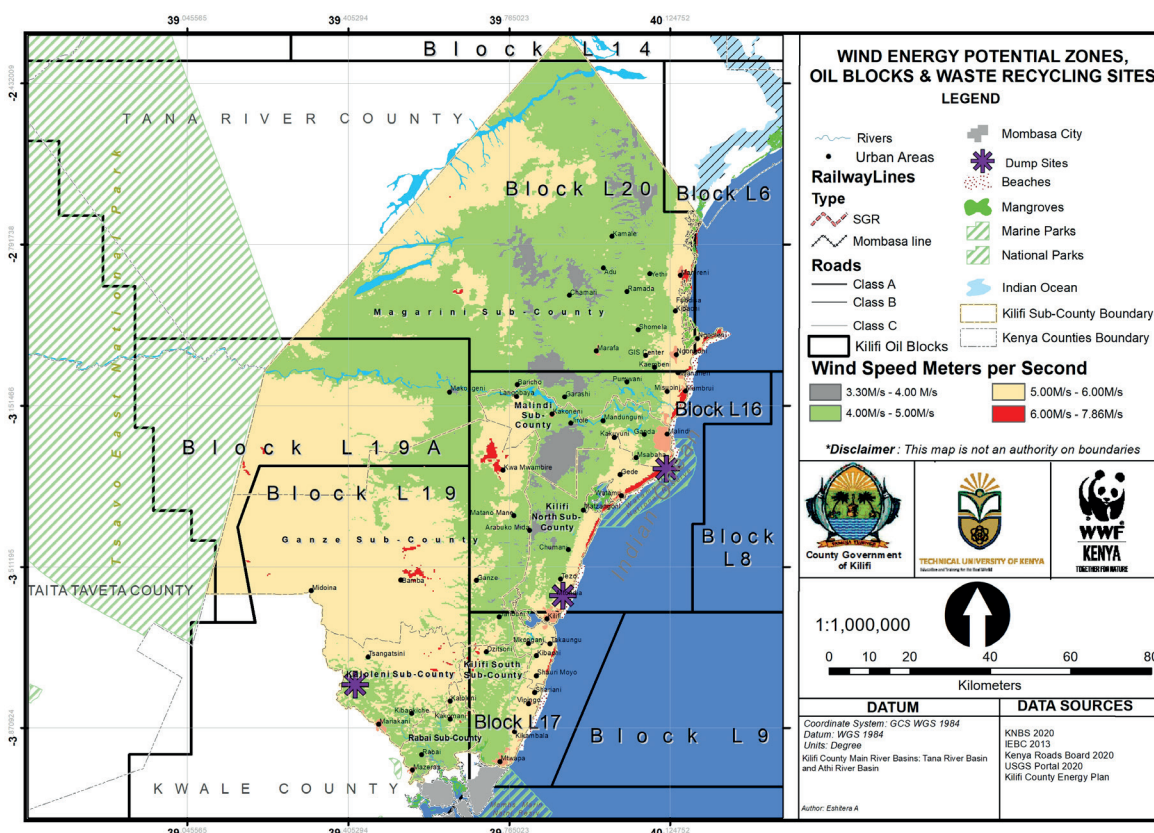
Developing and optimizing the utilisation of wind energy technologies is fundamental for supporting social, economic and political ventures for poverty alleviation and sustainable development. The meaningful exploitation of wind energy largely depends on the creation of an enabling environment to support both local and international investments in wind energy development. Towards this end, there is need to develop and optimize the utilisation of wind energy technologies to satisfy human wants as well as bolster socio-economic activities while lending support towards poverty and sustainable development. Malindi Confirmed wind energy potentials with 111W/m².

Figure 11: A GIS Map of Wind Energy Resources in Kilifi County



Source: (MINES ParisTech and Vaisala, 2018)

Figure 12: Wind Energy potential in Kilifi County



2.4 Municipal waste

Municipal waste includes solid waste such as durable and non-durable goods, containers, food scraps, yard waste, and inorganic waste from homes, institutions and businesses, wastes generated by manufacturing, agriculture, mining and construction and demolition debris, as well as sludge and liquid waste from water and wastewater treatment facilities, septic tanks, sewerage systems, slaughter houses. A Waste-to-energy (WtE) facility can help save space occupied by waste in landfills manage waste sustainably, generate electricity, and reduce the release of methane gas and toxic chemicals into ground water.

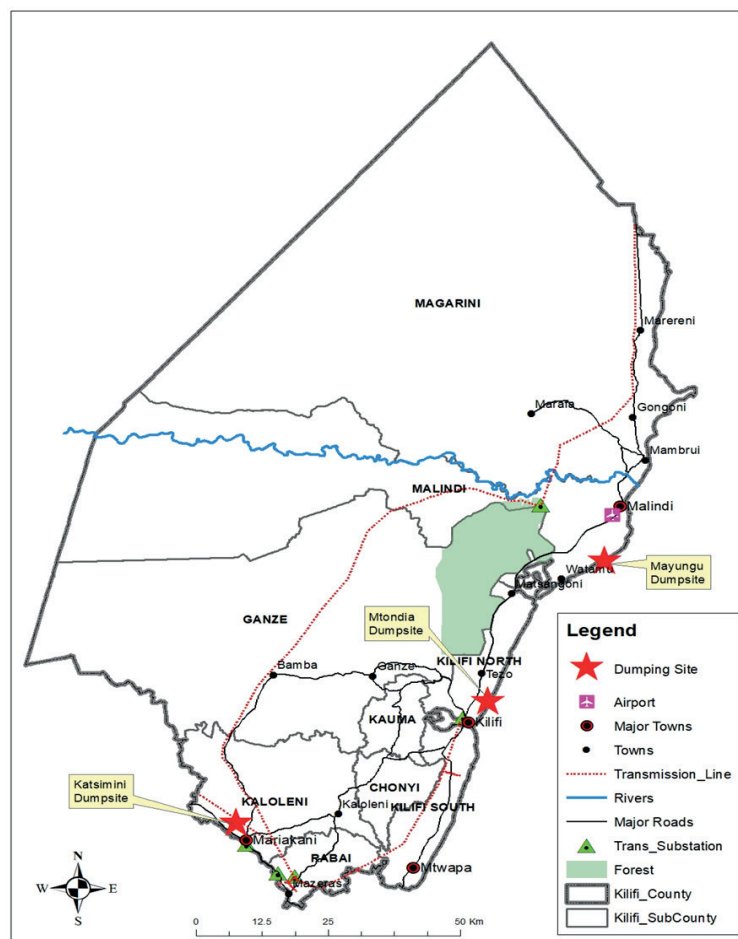
Figure 13 shows the three county municipal solid waste (MSW) dumpsites for namely Mayungu in Malindi, Katsimini in Mariakani and Mtondia near Kilifi town. Solid waste management shall be a shared responsibility amongst all actors including the county government, generators, owners and occupiers of premises and contracted service providers.

At 100% efficiency Kilifi County can collect and transport a total 770 tonnes per day of MSW to its three dumpsites (Kilifi County Government, Department of Water, Environment and Natural Resources, 2019). This MSW has the potential to run 13.5 MW WtE generating 108,093.33 MWh annually (County Government of Kilifi, October 2019). The proposed WtE site is at the Katsimini dumpsite (Figure 10) in Mariakani ward based on the following:

- Site is 2 km away from Kenya Electricity Transmission Company (KETRACO) transmission line
- The area is sparsely populated hence it is easy to site the WtE plant at a radius of between 300–500m radius from homesteads (Government of India, 2016). To minimise impact in case of explosion of the boilers.
- Close to Mombasa–Mtito Andei road. There are several urban centres along this high.

- Mariakani is designated for construction of industrial park which will require a lot of power and steam for their industrial processes
- The site is about 50 km from Mombasa County. This makes it cheap to transport waste from Mombasa to the site for processing.
- Figure 10: A GIS Map of MSW Dumpsites in Kilifi County

Figure 13: A GIS Map of MSW Dumpsites in Kilifi County



Source: (County Government of Kilifi, June 2020)

2.5 Fossil Fuel

2.5.1 Oil and Gas

Kenya has four major sedimentary basins for oil and gas exploration as shown in Table 13. The National Government is carrying out petroleum exploration both on-shore and off-shore with a view to discovering commercially viable oil and gas deposits in this basin. The discovery will reduce reliance on imported crude oil and other related products. According to Petroleum Act 2019, Part IV Clause 14. (1) All petroleum existing in its natural condition in strata lying within Kenya and its continental shelf is vested in the National Government in trust for the people of Kenya.

Table 13: The Major Petroleum Potential Sedimentary Basins in Kenya

Basin	Area (km ²)	Wells drilled	Average Sediment thickness (m)	Counties Covered
Lamu	261,000	16	12, 000	Part of Garissa, Tana River, Taita Taveta, Kitui and the entire counties of Lamu, Kilifi, Mombasa and Kwale running all the way into Indian ocean (off-shore)
Mandera	43, 404	3	10,000	Mandera and Wajir
Anza	81, 319	11	10, 000	Marsabit, Isiolo and Garissa
Tertiary Rift	105,673	3	4,000	Runs along the Rift Valley covering the Turkana, Marsabit, Samburu Baringo, Elgeyo Marakwet, West Pokot, Nakuru, Kajiado, Narok and Crosses over to Kisumu, Homa bay and Migori

The Lamu basin covers the whole of Kilifi County and contains 14 petroleum exploration blocks, as indicated in Table 14. Some of the blocks are on shore, others are extending from on shore to off shore while others are off shore. Oil and gas exploration are going on along the Kenyan coast with conditions becoming more favourable offshore. Analysis of hydrocarbon potential, however, is difficult from the limited data available. However, the most promising areas along the Kenya coast are the Lamu and Malindi regions. Figure 11 shows the GIS blocks of oil and gas resources and drilled wells in Kilifi County

Table 14: Kilifi County Petroleum Exploration Blocks

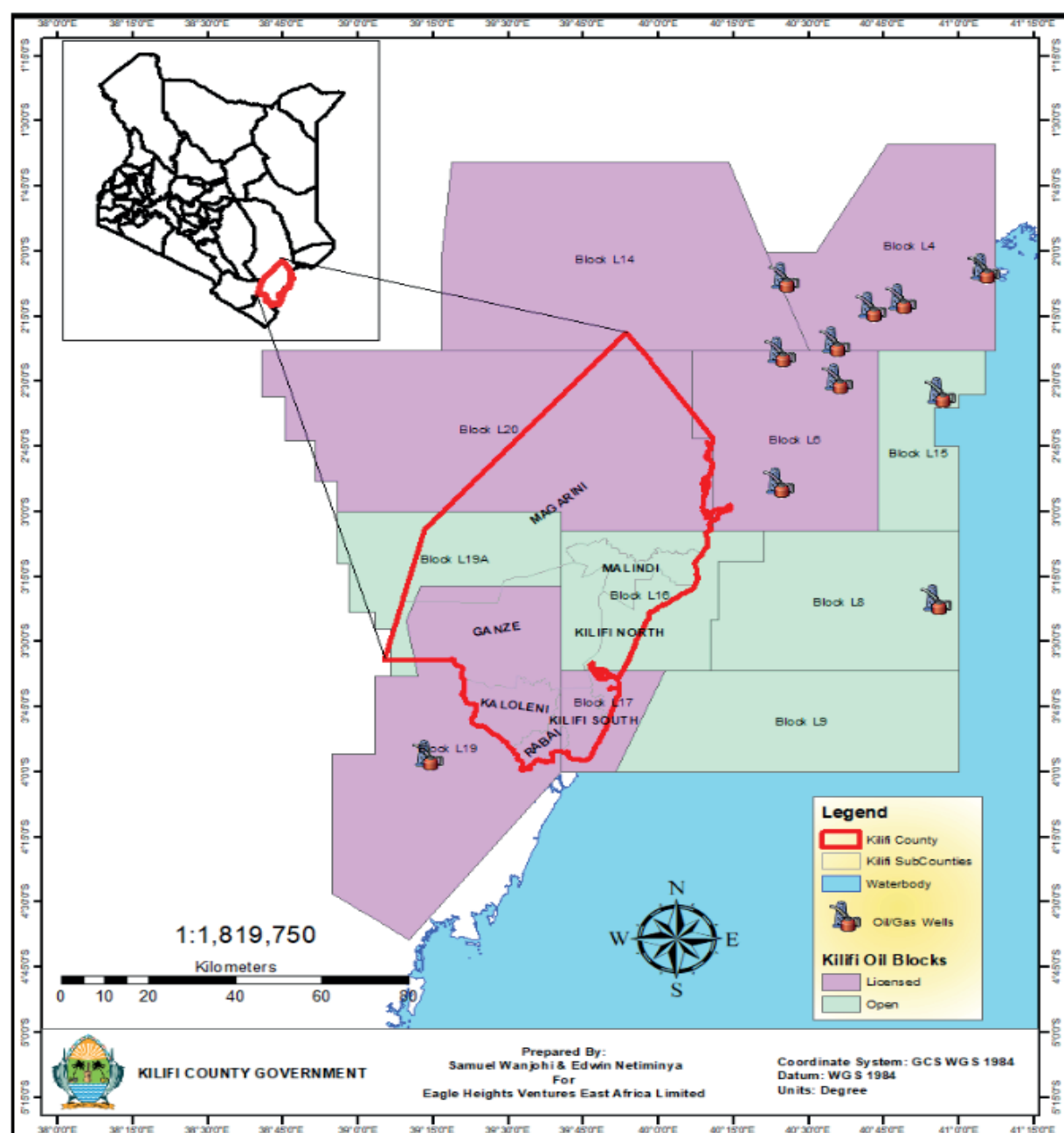
Block No.	Location	Exploration Company	Wells Drilled
1. BL 20	Onshore block covering Magarini of Kilifi County and part of Tana River County bordering Kilifi	Milio International	
2. BL 16	On/Off shore covering Malindi	Open	
3. BL 19A	On shore covering Magarini and parts of the Tana River and Taita Taveta bordering Kilifi	Open	
4. BI 17	On/Off shore covering Kilifi North and kilifi South	Octant Energy	
5. BL 19	Ganze and Kwale county	Rift Energy	1 (Ria Kaluli 1—Kwale side)
6. BL 6	Off/On shore mostly in Tana River extending to Kilifi and Lamu	Afar Energy	1
7. BL 8	Off shore malindi	Open	Mbawa 1—Gas discovery
8. BL 9	Offshore	Open	
9. BL 11A	Offshore	ENI E&P	
10. BL 11B	Offshore	ENI E&P	Kiboko 1
11. BL 12	Offshore	ENI E&P	
12. BL 25	Offshore	Open	
13. BL 26	Offshore	Open	
14. BL 27	Offshore	Open	
15. BL 28	Offshore	Open	

Source: ArcGIS Kenya Petroleum Exploration Map

In 2013, CAMAC Energy Kenya was issued permits to oversee oil and gas surveys within Arabuko-Sokoke forest, which would have involved underground drilling and seismic activity. Arabuko-Sokoke falls under block L16. However, the Arabuko-Sokoke Forest Adjacent Dwellers Association (ASFADA), Gede Community Forest Association, Jilore Community Forest Association, Sokoke Community Forest

Association, Nature Kenya (BirdLife Partner), A Rocha Kenya, the Kenya Forests Working Group and others appealed to the NEMA, the Ministry of Energy, the Ministry of Environment, Water and Natural Resources and the Kilifi County Government to stop any seismic survey or drilling within the Arabuko-Sokoke Forest immediately. There is concern that there was no proper consultation about the proposed surveys for oil and gas, and that the Environmental Impact Assessment (EIA) and its approval by the NEMA did not follow required community participation and public consultation. Camac Energy cancelled its plans to carry out seismic survey of coal and gas within Arabuko-Sokoke Forest coastal forest amid fears that it would make rare wildlife extinct and devastate local people's livelihoods.

Figure 14: A GIS Map of Blocks of Oil and Gas Resources and Drilled Wells in Kilifi County



Source: (County Government of Kilifi, June 2020)

2.5.1.1 Coal

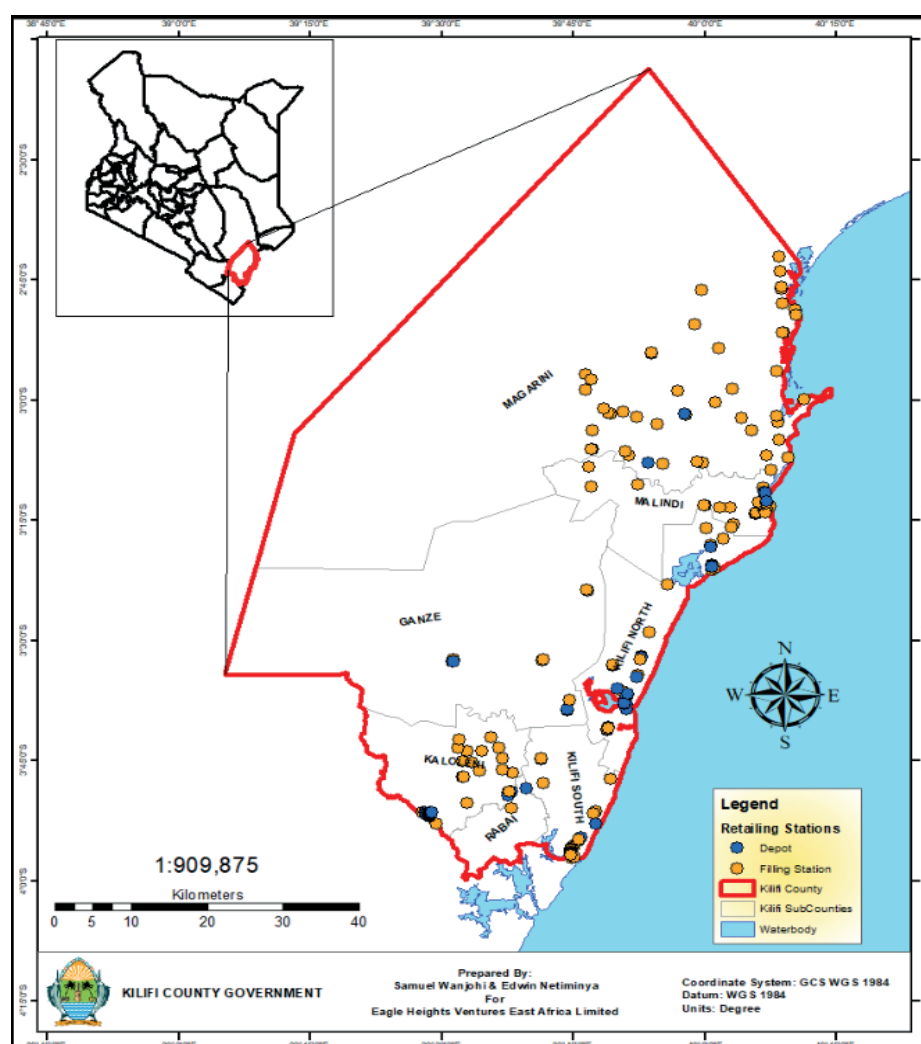
The Taru basin, which runs across Kwale and Kilifi counties, is believed to have significant coal deposits along with large deposits of rare minerals such as gypsum, Titanium and Zircon and gas reserves. Taru basin covers 900 km².

2.6 Energy Infrastructure

2.6.1 Stations Retailing Petroleum Fuels

Kilifi County has 97 petrol stations, 74 filling stations (small petrol stations), 33 informal petroleum points, 43 LPG cylinder retailing depots, 2 LPG cylinder refilling stations, and 5 informal LPG cylinder points. Figure 15 shows the GIS maps of petroleum retail stations.

Figure 15: A GIS Map of Retailing Stations for Petroleum (Diesel, Petrol, Kerosene and LPG) Fuel



Source: (County Government of Kilifi, June 2020)

2.6.2 Power Grid Infrastructure in Kilifi County

The power grid is a network for delivering electricity to consumers, consisting of transmission and distribution lines, substations, transformers, and other components that deliver electricity from power plants to industry, commercial and residential consumers, meeting ever-growing power demands. The network of transmission and distribution facilities makes up the power grid. This interconnected grid enhances reliability of power system significantly. In case of failure of any generating station or if the load curve of power station indicates peak demand exceeding the rated capacity of the power station, then the load or excess load can be shared by other power stations interconnected to it. The electric power from the generation station is stepped up to a high voltage for transmission. On arrival to a primary substation, the power is stepped down from the transmission voltage to a distribution level voltage. Finally, on arrival at the service location, the power is stepped down by a secondary substation from the distribution voltage to the required service voltage(s). The Kenyan power system includes:

- a) **Transmission Network:** A double circuit 400 kV line capable of evacuating up to 1,500 MW over approximately 1,022 km from Mombasa through Nairobi and Suswa in Naivasha to Loiyangalani in Marsabit County. This includes a 220 kV national grid branching into 132 kV and 66 kV levels, designed for up to 220 kV operating voltage at a nominal fundamental system frequency of 50 Hz.
- b) **Distribution Network:** Comprises voltage levels of 33 kV and 11 kV and the low voltage system. Electricity is supplied to end consumers on different voltage levels up to 132 kV.

1. Power Generation Plants

Kilifi County has three power generation stations connected to the national power grid namely;

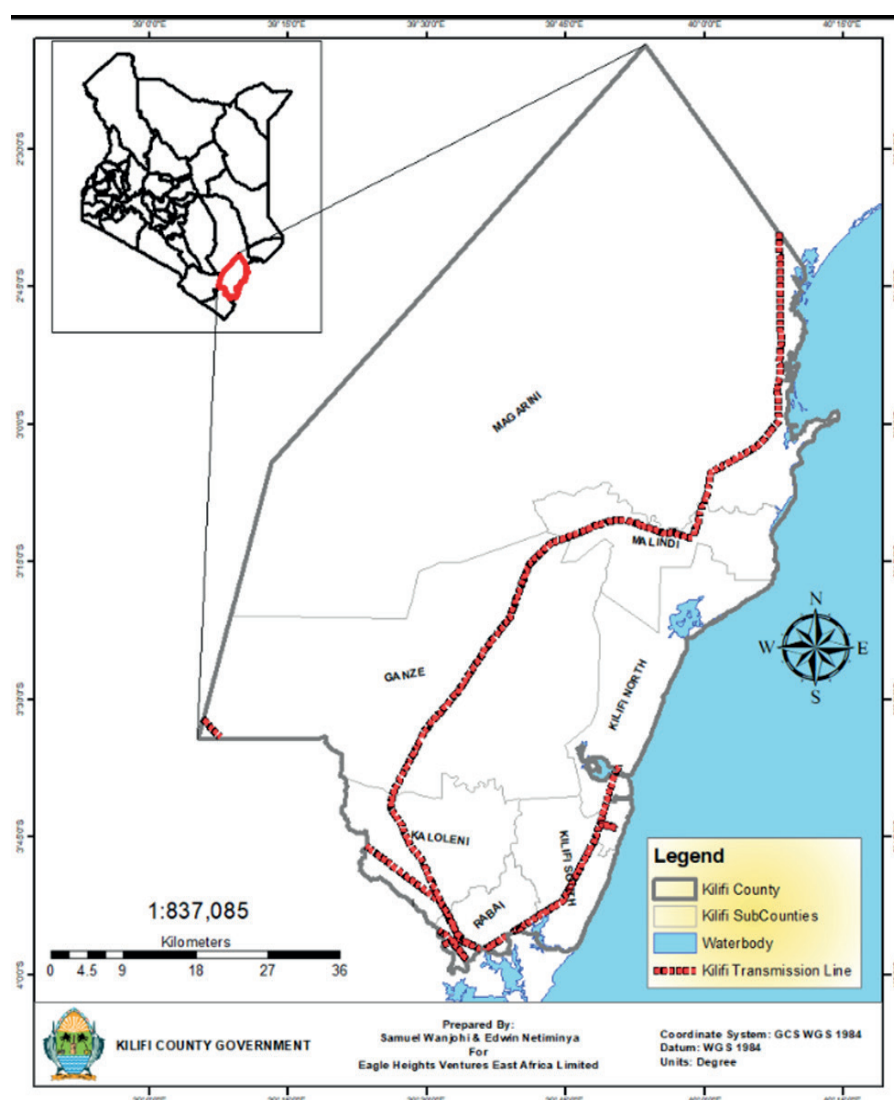
- 90 MW Rabai Thermal Power plant,
- 40 MW Malindi Solar PV plant, and
- 0.5 MW Rea Vipingo Biogas Plant.

2. Transmission Lines

- Kilifi County is served by the 132 kV Rabai–Bamburi–Kilifi transmission lines (covering a distance of 182.6 km) and the 220 kV Rabai–Malindi–Garsen–Lamu transmission line projects (covering a distance of 92 km).
- The availability of the transmission line in the county is an attraction to investors planning to set up power generating plant.



Figure 16: A GIS Map of Rabai–Malindi–Garsen Transmission Line



Source: (County Government of Kilifi, June 2020)

3. Bulk Power Supply Sub-stations

- Bulk Power Supply Stations (BPSs) transfers power from transmission line to any distribution systems.
- Kilifi County has 5 BPSs with a total installed capacity of 428.5 MVA The stations are:
 - ▶ Kilifi 132/33/11 kV;
 - ▶ Rabai 400/200/33/11 kV;
 - ▶ Kakuyuni 200/33 kV;
 - ▶ Mariakani 132 metering station and;
 - ▶ Kokotoni 132 metering station.

- The substations are located at the following sub-locations
 - ▶ Konjora,
 - ▶ Kisurutini/Mwele/Simak,
 - ▶ Kakuyuni Mariakani/Mitangoni and
 - ▶ Kaliangombe respectively.

4. Primary Substations

Kilifi County has 18 primary sub-stations with an installed capacity of 85 MVA, 3 (Umoja Rubber, Athi River Mining and Pwani oil) of which are connected to single consumers. The 11 kV and 33 kV voltage lines covers a distance of 680.5 km and 1,508.26 km respectively. Table 15 shows the details of 14 the sub-stations.

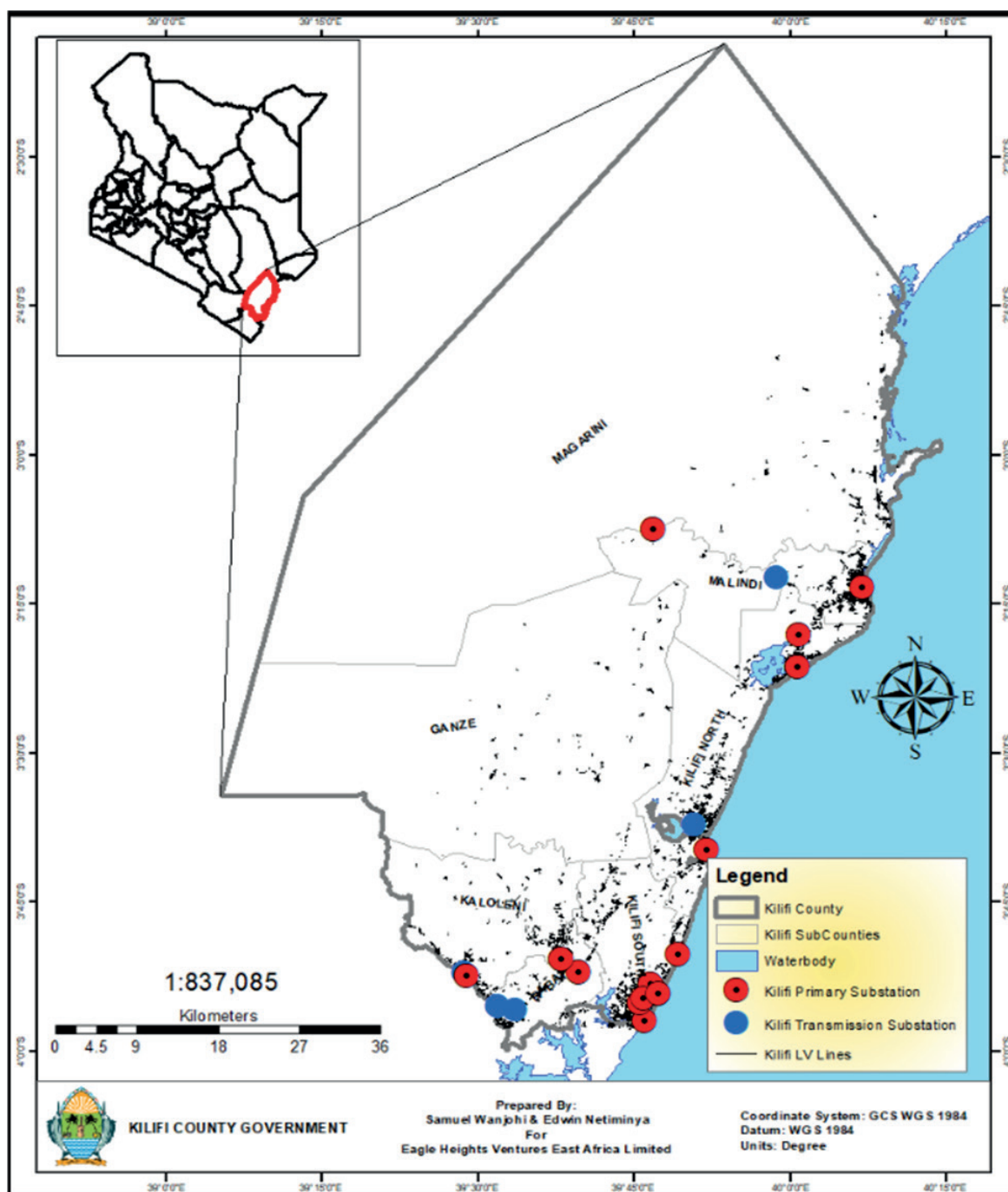
Table 15: Primary Substations in Kilifi County

Location	Sub-location	Name
1. Mtwapa	Kanamai	Umoja Rubber 33 kV metering substation
2. Kambe	Mbwaka/Kikomani	Athi River Mining 33 kV metering substation—Rabai
3. Pwani Oil	Pwani Oil	Pwani Oil 33 kV metering substation
4. Mariakani	Mariakani/Mitangoni	Mariakani 33/11 kV substation
5. Mtwapa	Kijipwa	Kikambala 33/11 kV substation
6. Malindi Town	Barani	Malindi 33/11 kV substation
7. Gede	Mijomboni	Gede 33/11 kV substation
8. Kambe	Kambe/Maereni	Ribe 33/11 kV substation
9. Mtwapa	Shimo la Tewa	Mtwapa 33/11 kV substation
10. Langobaya	Langobaya	Baricho 33/11 kV substation
11. Junju	Vipingo/Gongoni	Kuruwitu 33/11 kV substation
12. Township	Mnarani	Kilifi Plantation 33/11 kV substation
13. Watamu	Watamu	Watamu 33/11 kV substation
14. Mtwapa	Kanamai	Kanamai 33/11 kV substation

Source: Kilifi County—Kenya Power Office 2018



Figure 17: GIS Map of Transmission and Primary Substation in Kilifi County

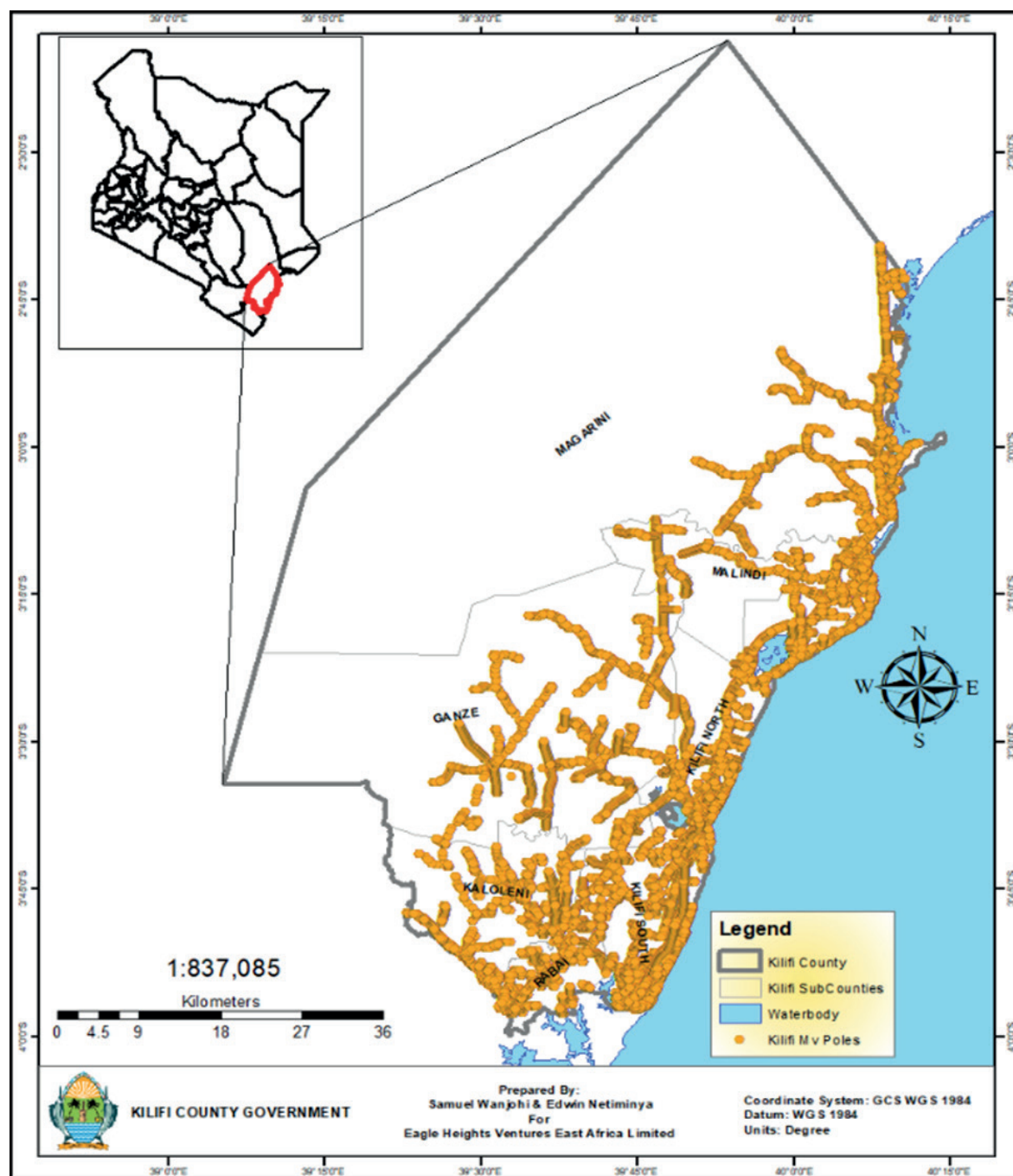


Source: (County Government of Kilifi, June 2020)

5. Medium Voltage (MV) Poles (1 kV–33 kV)

Figure 17 shows the distribution of medium voltage poles in the County. The distribution covers approximately a half of one side of the county.

Figure 18: GIS Map of Medium Voltage (MV) Poles (1 kV–33 kV) in Kilifi County

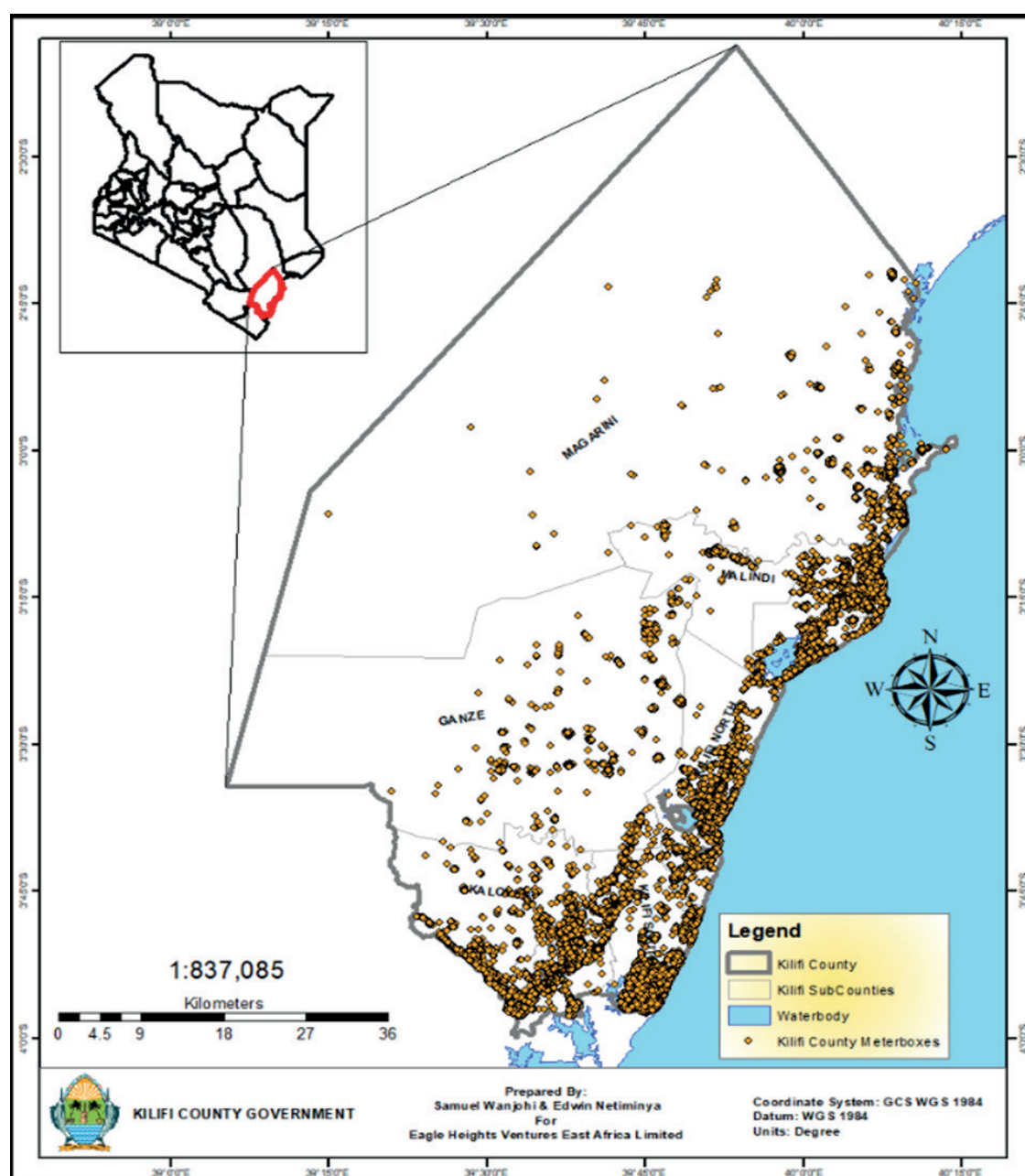


Source: (County Government of Kilifi, June 2020)

6. Distribution of Meter boxes

The distribution of meter boxes indicates customer connectivity to the national grid, as shown in Figure 18. The figure indicates customer connectivity is very low in the sub-counties of Magarini and Ganze. According to Kenya Power, the Kilifi county has 1,644 transformers across the county with an installed capacity of 253,125 MVA.

Figure 19: GIS Map of Distribution of Meter boxes in Kilifi County



Source: (County Government of Kilifi, June 2020)

[1] <https://eie.uonbi.ac.ke/sites/default/files/cae/engineering/eie/RENEWABLE%20ENERGY%20SOURCES-KENYAN%20CASE%20STUDY-PROJECT.pdf>

[2] http://www.kilifiassembly.go.ke/images/SOLID_WASTE_MANAGEMENT_BILL_2016.pdf

Table 16: A summary of County Energy Resources

PROSPECTIVE SOURCES					
Sector	General description	Potential energy capacity	Unit of Measure	Status of Exploitation	Location ²
Waste					
Cattle manure (for conversion into biogas)	Number of farmers with potential to uptake biogas technology	64% of household in Ganze and Magarini owning over 10 cattle	No. of potential 8–12 cubic metre digesters	Marginal	All over the county
Municipal waste	Waste collected and transported to dumping sites per annum	770	Tonnes/day	Nil	Mayungu, Mtondia and & Katsimini dumpsites
Solar					
	Global Horizontal Irradiation (GHI)	5.1–6	kWh/m ² /day	Minimal	Good potential all over the county with the best resources are in the eastern sides of the county towards the ocean. The GHI is close to 6 kWh/m²/day The less-endowed county regarding the solar resource is the Northern part of the County with a GHI of 5.173 kWh/m²/day. The western sides of the county has an average GHI of 5.4 kWh/m²/day.
Wind					
	Wind speeds of above 9 m/s at a height of 100m above ground level	5–7	m/s at a height 50 m	Two wind power	The coastal strip, significant parts of Ganze, parts of Kaloleni and Magarini have potential sites for commercial investment in wind energy.
Hydro power					
		Several sites	No. of sites	Nil	Sites along rivers Sabaki

² This information is better presented in a GIS map where a county has capacity



Chapter 3: ENERGY ACCESS

3.1 Introduction

Energy access entails providing modern energy services to everyone. The International Energy Agency (IEA) defines a household as having energy access when it has reliable and affordable access to both clean cooking facilities and electricity. The energy should be enough to supply a basic bundle of energy services initially, and with the level of service capable of growing over time (International Energy agency, November 2019). A basic bundle of electricity services should encompass, at a minimum, several light bulbs, phone charging, a radio and potentially a fan or television. Despite their development benefits, “pico solar” products, mainly solar lanterns which may include mobile phone chargers, are considered to be below the minimum threshold to count as having access. Access to clean cooking facilities means access to (and primary use of) modern fuels and technologies, including natural gas, LPG, electricity, bioethanol, and biogas, or improved biomass cookstoves which deliver significant improvements compared with basic biomass cookstoves and three-stone cookstoves. Improvements in pollutant levels from improved biomass cookstoves were often overstated, with virtually no biomass cookstoves on the market meeting WHO standards for exposure to household air pollution.

3.2 Access to Electricity

3.2.1 Policies and Regulatory Framework

3.2.1.1 The Feed in Tariff Policy 2012

The Feed-in-Tariff (FiT) Policy 2012 was issued in 2008 and revised in 2010 and 2012. This Policy was formulated to promote investment in electricity generation from renewable energy sources

3.2.1.2 Electricity Regulations

- a) The Electric Power (Electrical Installation Work) Rules, 2006,
- b) The Energy (Complaints and Dispute Resolution) Regulations, 2012
- c) The Energy (Electricity Licensing) Regulations, 2012
- d) Kenya Green code
- e) Least Cost Power Development Plan (LCPDP)
- f) Rural Electrification Master Plan
- g) Kenya Country Action Plan (KCAP), 2013

3.2.1.3 Renewable Energy Regulations

- a) The Energy (Solar PV Systems) Regulations, 2012
- b) Designation of Energy Users Gazettement
- c) The Energy (Energy Management) Regulations, 2012



- d) The Energy (Solar Water Heating) Regulations, 2012
- e) Charcoal Rules, 2009.
- f) The Biogas Regulations (Draft)
- g) Improved Biomass Cook Stove Regulations, 2012 (Draft)
- h) The Energy (Biodiesel Licensing) Regulations, 2009 (Draft);
- i) Kenya Mini-grids Regulatory Framework (under development)
- j) Feed-In-Tariff (FiT) Policy

3.2.2 Key Stakeholders in Electricity Access

The Ministry of Energy (MOE) holds responsibility for crafting policies and overseeing their implementation to foster an environment conducive to the efficient operation and expansion of the energy sector. It establishes the strategic trajectory for sector development and offers a long-term vision guiding all stakeholders within the industry.

The Kenya Power and Lighting Company (KPLC) serves as the system operator and primary off-taker within the power market, procuring bulk power from various generators through negotiated PPAs for distribution to consumers. Additionally, KPLC is responsible for owning and managing a portion of the current transmission infrastructure and the majority of the interconnected distribution network.

As per the Energy Act of 2019, the **Rural Electrification and Renewable Energy Corporation (REREC)** has been designated as the principal authority responsible for advancing renewable energy resources, excluding geothermal and large hydropower. This expanded mandate complements its existing role in rural electrification efforts.

The Kenya Electricity Transmission Company (KETRACO) is tasked with planning, designing, constructing, owning, operating, and maintaining new high-voltage (132 kV and above) electricity transmission lines. These lines serve as the core infrastructure of the National Transmission Grid and regional interconnections. This initiative further aims to foster the development of an open-access system within the country.

The Kenya Electricity Generating Company (KenGen) serves as the primary power generation entity within the country and is renowned for its extensive expertise in geothermal technology development.

The Energy and Petroleum Regulatory Authority (EPRA) oversees the economic and technical aspects of the energy sector. Its responsibilities encompass licensing power sector facilities and technicians, conducting energy audits, setting tariffs, and providing sector oversight. Additionally, EPRA develops and implements regulations, ensuring compliance and enforcement across the sector.

The Nuclear Power and Energy Agency (NuPEA) is tasked with advancing the nuclear energy programme in Kenya, promoting the development of nuclear electricity generation, and conducting research, development, and dissemination activities of energy-related research findings. Additionally, NuPEA facilitates and coordinates capacity-building initiatives within the energy sector.



Independent Power Producers (IPPs) are private investors in the power sector engaged in electricity generation, either on a large scale or for the development of renewable energy projects under the FiT Policy.

County Government: According to Schedule Four of the Kenyan Constitution of 2010, section 5(b) and 8(e), the county government, through the Department of Transport, Public Works, Infrastructure, and Energy, is tasked with the responsibility of overseeing street lighting in the county.

3.2.3 Past and Current Initiatives on Electricity Access

1. Kenya Power Projects

- a) **The Global Partnership on Output-based Aid (GPOBA):** This is a project funded by Kenya Power and the World Bank with an aim of providing a safe, legal, and high-quality power supply to customers in informal settlements in Kenya at subsidised rates. There are targeted informal settlements in Kilifi County.
- b) **Mwangaza Mtaani Street Lighting Project:** Major urban towns within the County, such as Mtwapa, Kaloleni, Malindi, Kilifi, Mariakani, Vipingo, and Mazaras, have benefited from this project.
- c) **The Boresha Umeme Project:** This is a rapid results initiative whose approach entails maximizing human and capital resources to upgrade the electricity network in industrial areas, high growth areas, major towns, and townships within the County. The project, initiated in 2014, involves upgrading existing power networks and infrastructure, including power substations, extension of existing power, and replacement of wooden poles with concrete poles in all major towns in the county.
- d) **Distribution Master Plan 2023–2026**
 - Upgrade of a substation at Kakuyuni in Malindi to enhance its capacity to 220/33 kV, 1x23 MVA in 2022
 - Upgrade of one overhead line (14 km from Casuarina to Malindi) to enhance its capacity to 11 kV, 150 ACSR, to reduce electrical losses in 2023
 - Upgrade of two overhead lines (12 km from Mazaras to Miritini) to enhance their capacity to 11 kV, 150 ACSR, to reduce electrical losses in 2023

2. **Last Mile Connectivity:** Every household within a radius of 600 metres from a transformer will be connected to the grid. The second and third phases will seek to connect the remaining households and bring connectivity in the country to 70%.

3. Kenya Off-grid Solar Access Project (KOSAP) 2017–2024

The following projects are being implemented by the KOSAP Project:

- Construct three mini-grids at Bombi, Chakam, and Kirepwe to serve approximately 300 households.
- Support private companies to supply about 15,000 solar home systems and 935 improved cookstoves to households in Kilifi County.
- In addition, the project will install standalone solar PV systems in 13 schools, 8 secondary schools, 1 primary school and 2 assistant chief's offices, along with one booster pump and 13 boreholes.



4. **Energy 4 Impact Project**

- In the year 2020, Energy 4 Impact, through the ‘Jua Project,’ installed Solar PV systems in 14 public clinics, 3 secondary schools, and 56 primary schools.

5. **County and Constituency Collaborations**

This is a project where the Corporation matches contributions from constituencies and counties to a maximum of **KES 5 million per constituency** for the implementation of rural electrification and renewable energy projects.

6. **County Government (Street Lighting)**

- In the financial year 2021/2022, Kilifi County Government launched 11 solar street lighting and 74 (22 grid-connected and 52 solar PV) high mast lighting projects in all 7 sub-counties of Kilifi County, and these projects have been completed. (See the annex)
- In the financial year 2020/2021, Kilifi County Government launched 13 solar PV streetlights and 77 (11 grid-connected and 66 solar PV) high mast lighting projects in all 7 sub-counties of Kilifi County, and these projects have been completed. (See the annex)

7. **KETRACO Projects**

- 132 kV Rabai–Bamburi–Kilifi—Rehabilitation of the existing 132 kV line from wooden poles to steel towers, establishment of a 2x45 MVA 132/33 kV substation at New Kilifi, and construction of an additional 132 kV circuit from Rabai to Kilifi (approximately 63 km). Due date for completion is 2024.
- Mariakani 400/220 kV Substation—Establishment of a 400/220 kV, 2x200 MVA substation at Mariakani. Due date for completion is 2024.

8. **Private Ongoing Project by Mwahera Green Hydrogen Limited**

1,000 MW Mwangea Solar Captive Solar PV Farm at Mwahera

Mwahera Green Hydrogen Limited is a company incorporated in Kenya whose major partners are Mwangea Green Hydrogen Ltd of Kenya and Galetch Energy Development Ltd of Ireland. The company has proposed a project called the Mwangea Green Ammonia Project, whose intention is to produce green ammonia using renewable energy. The captive solar will be used in generating green ammonia—about 300,000 tonnes per annum. The project is expected to consume 400 megawatts from the national grid during peak hours. It is proposed to be located in Mwahera sub-location, Mwahera location, Vitengeni division. The project proponent is Mwahera Green Hydrogen Limited.

3.2.4 Electricity Access Situation

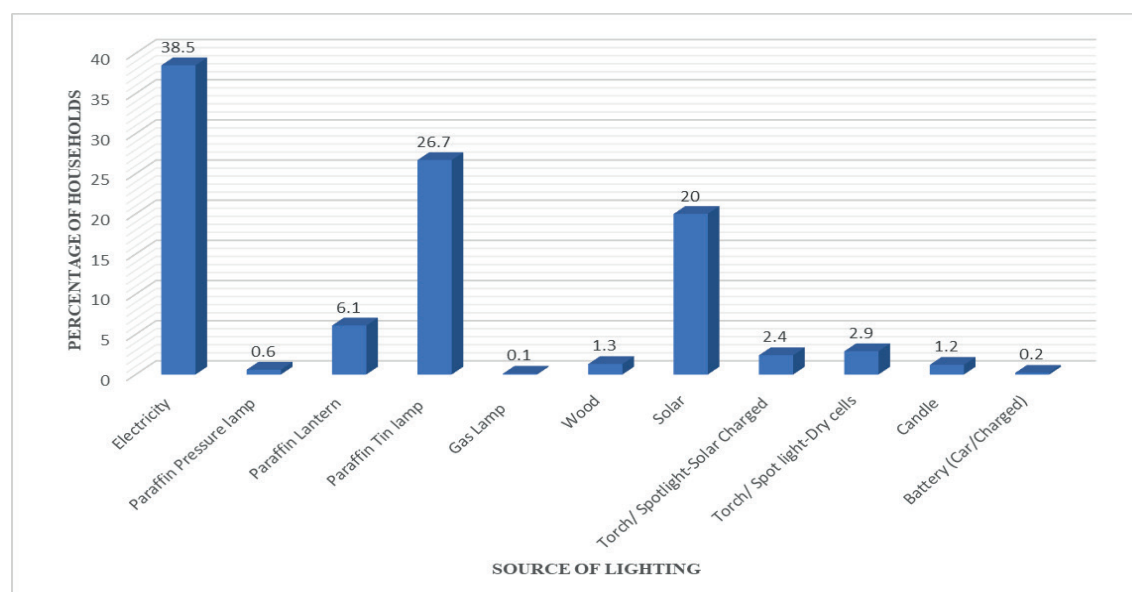
In Kilifi County, the national grid is well developed on the coast and along the main roads. Today, 68% of the total population already lives in an electrified settlement, and 85% are located less than 1.6 km (one mile) from the interconnected network. Therefore, Kilifi County has a good base for the electrification of the remaining households. However, even if the population coverage rate is good, universal access to electricity in the County remains a challenge. Indeed, a lot of “under grid” households are not connected, which reflects real problems around connectivity. Beyond the many technical and social factors that can impact access and quality of service, low connectivity access can mainly be explained by the connection cost which is out of reach for most of the poor and rural households.



3.2.4.1 Households

- At the end of 2023, 34% of the households living in the County are still not connected to the national grid³. At the same time, analysis conducted as part of developing the KCEP shows that 79% are within connection distance of an existing transformer (600 metres as the accepted government definition).
- Reasons for this are likely to include affordability, challenges in getting connected, relatively low electricity consumption, and associated demand from many lower-income households.
- From Figure 20, the use of electricity in Kilifi County is the highest, standing at 58.5%, with grid electricity contributing 38.5% and standalone Solar PV systems 20% (Government of Kenya, KNBS Census, 2019). The use of paraffin for lighting is second highest, standing at 33.4%, with the use of tin lamps, lanterns, and pressure lamps contributing 26.7%, 6.1%, and 0.6%, respectively. **Therefore, the population in Kilifi County with no access to electricity stands at 41.5%** (Government of Kenya, KNBS Census, 2019).

Figure 20: Percentage Distribution of HHs by Lighting Fuel Source in Kilifi County

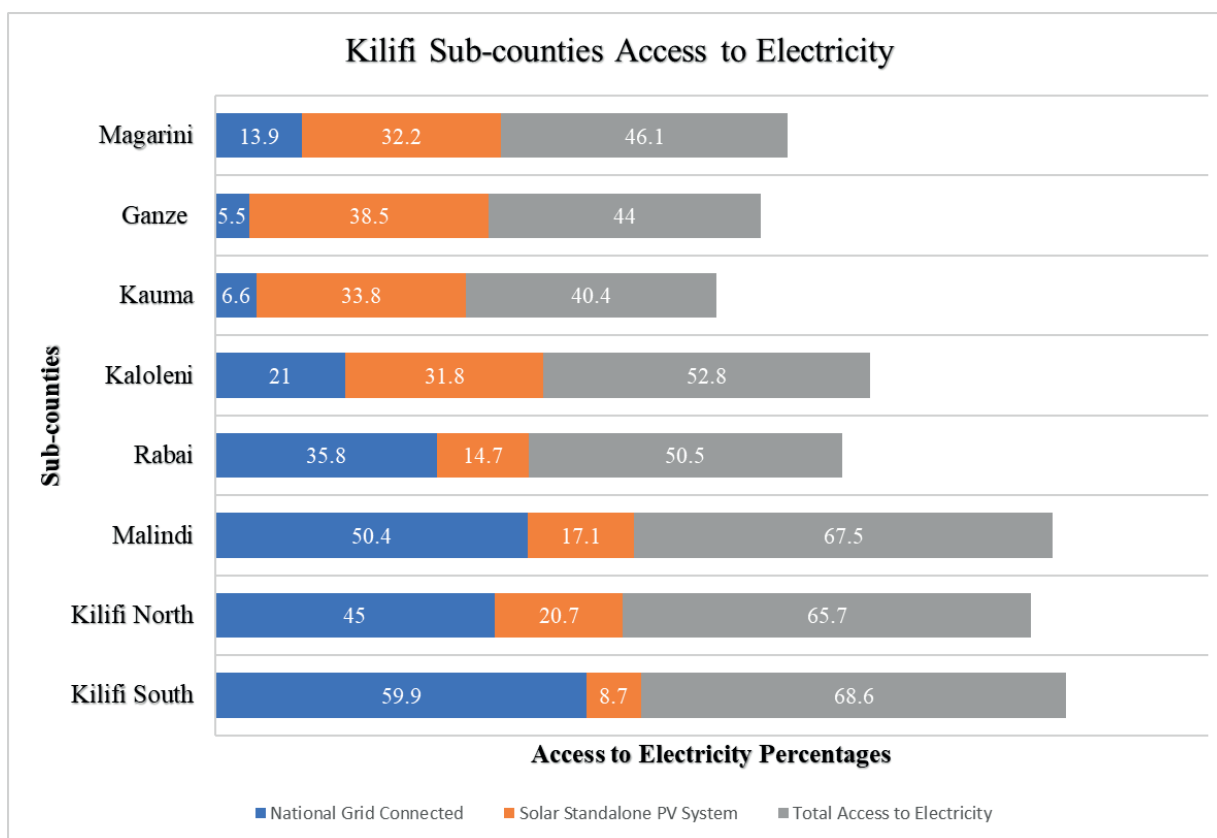


Source: (Government of Kenya, KNBS Census, 2019)

Figure 21 shows the status of electricity access for the nine sub-counties of Kilifi County namely; Chonyi, Ganze, Kaloleni, Kauma, Kilifi North, Kilifi South, Magarini, Malindi and Rabai.

³ By September 2023, KPLC registered 195,770 domestic clients, while the number of households was 297,290.

Figure 21: Kilifi Sub-counties Access to Electricity Status



Source: (Government of Kenya, KNBS Census, 2019)

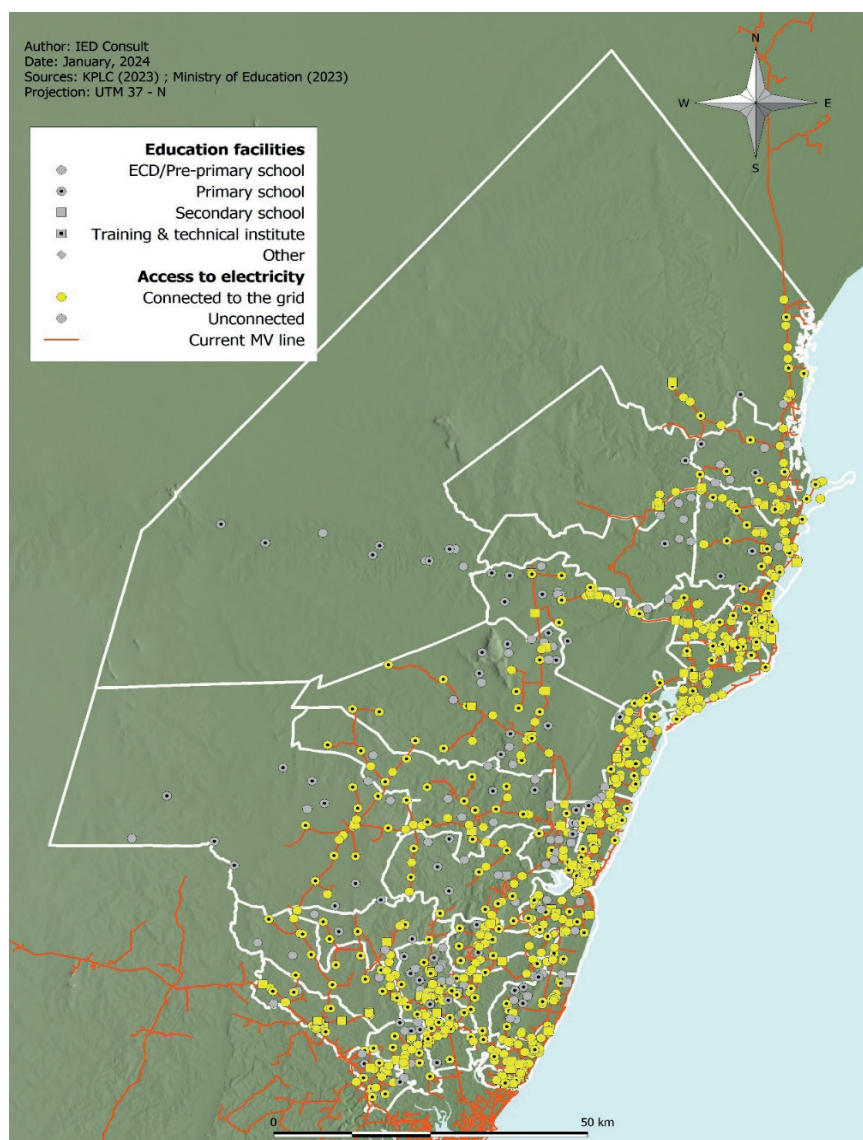
3.2.4.2 Institutions

3.2.4.2.1 Institutions

Kilifi County has various institutions, which include schools, mid-level colleges, universities, and health facilities. Connection of electricity to learning institutions enables students to have early morning and evening studies, learn computer studies, and practical lessons. The following is the status of various institutions and load centres in Kilifi County.



Figure 22: Electrification status of education facilities



1. Early Childhood Development and Education (ECDE) Centres

Kilifi County has a total of 928 ECDE centres consisting of 604 public, 149 religious organisations, and 175 privately owned (Government of Kilifi County, Energy Department, March 2023). Currently, 41 VICs are operational, and 13 of them don't have electricity. Table 17 shows the electrification status of ECDE centres in the County based on ownership.

Table 17: Electrification Status of ECDE

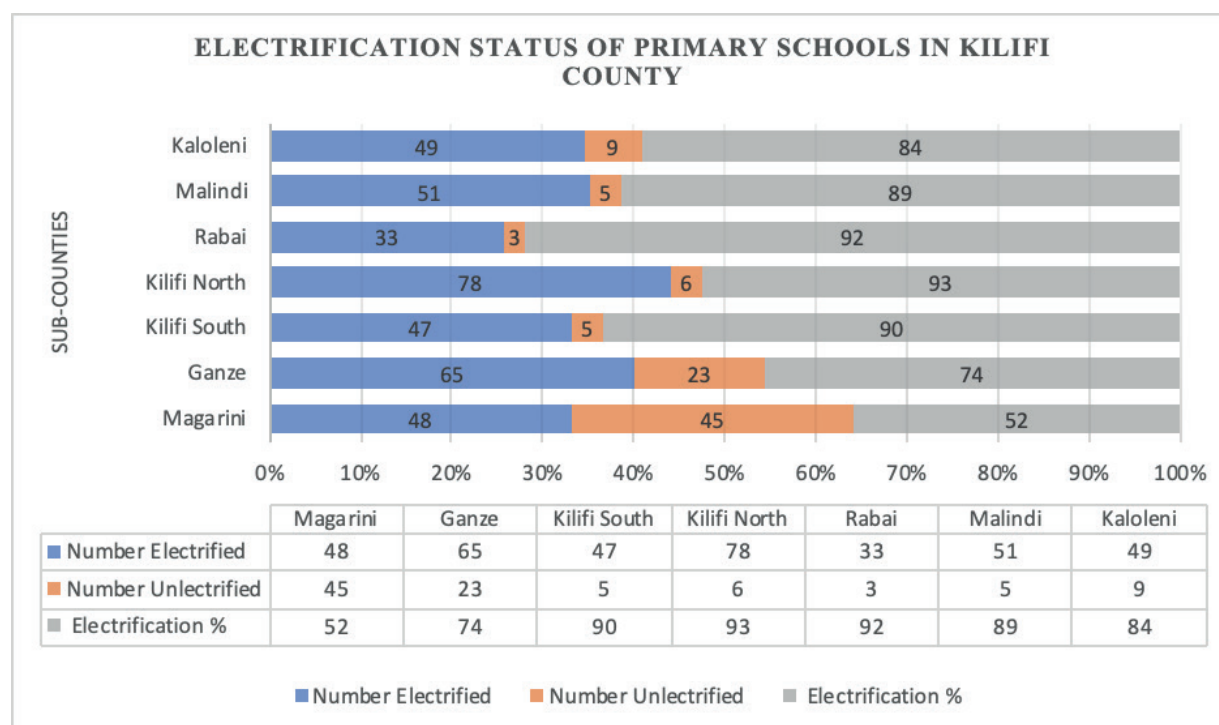
Ownership		No. Electrified	No. Unelectrified	Total No.	Electrification %
Public		327	277	604	54.13
Private	Religious organization	115	34	149	77.18
	Private Entities	137	38	175	78.29
Total		579	349	928	

Source: Kilifi County GIS Energy Database 2020

2. Primary Schools

According to the County Directorate of Education in Kilifi (National Government), there are a total of 96 primary schools in need of electrification. This represents 17.17% of the total number of public primary schools in Kilifi County (Government of Kenya, Ministry of Education, 2020). Institutions names are provided in the annex. In addition, there are 36 primary schools managed by religious organisations and 74 by private entities. The overall electrification rate for religious and private-entity-managed primary schools stands at 90% (32 and 67 of the religious and private-entity-managed primary schools are electrified). Figure 23 shows the electrification status of public primary schools per sub-county.

Figure 23: Electrification Status in Public Primary Schools



Source: Ministry of Energy 2019



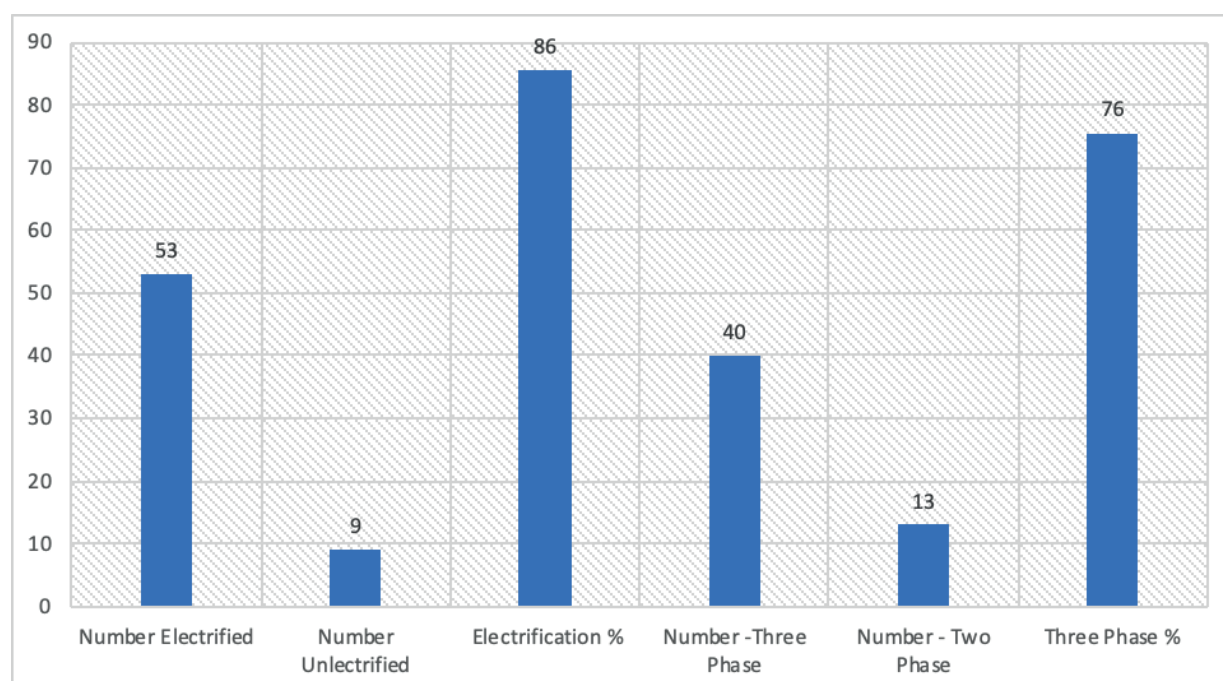
3. Secondary Schools

Kilifi County had a total of 132 public secondary schools as of 2023 (Kilifi County Education Office—Ministry of Education, March 2024), and all of them are electrified.

4. Middle-Level Colleges

According to the county directorate of Vocational Training, there are 53 Vocational and Technical College (VTCs) in the county. Out of these 53, 21 are connected to 3-phase grid power, 13 are connected to single-phase grid power, which has been rated as insufficient, while 19 do not have any source of power supply. Figure 24 shows the electrification status of middle-level colleges. The grid proximity status of the 19 institutes without a power supply is unknown but has been approximated based on the grid penetration rate.

Figure 24: Electrification Status of County Vocational Technical Training Colleges

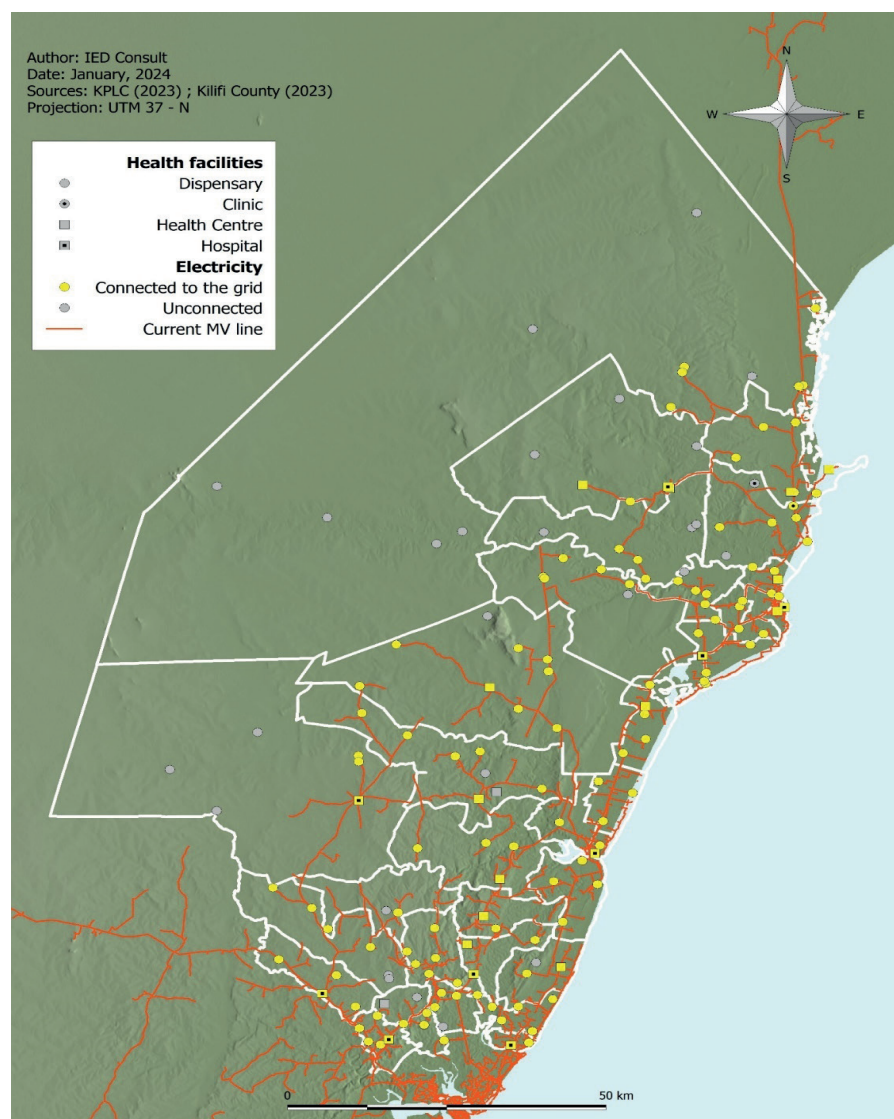


Source: SETA Baseline Surveys

5. Health Facilities

Kilifi County has 147 health facilities exclusive of those owned by the private sector. These facilities include hospitals, health centres, dispensaries, and clinics/nursing homes. Health facilities in Kenya are classified as Level 6 (National Referral Hospitals), Level 5 (County Referral Hospitals), Level 4 (Sub-County hospitals), Level 3 (Health Centres), and Level 2 (Dispensaries/Clinics). Level 6 hospitals are owned by the National Government, while the rest are owned by County governments. Kilifi County has 2 level 5 hospitals, 8 level 4 hospitals, 16 level 3 hospitals (Health Centres), and 123 level 2 hospitals (Dispensaries/Clinics) (Kilifi County Government, 2022). All hospitals are required to have a reliable source of electricity to run their activities effectively and efficiently 24/7. A standby source of electrical power should be available to ensure the continuation of critical services like ICU, HDU, and theatre operations.

Figure 25: Electrification Status of Health Facilities



Source: SETA Baseline Surveys

In Kilifi County, the capacity of Solar PV panels installed is quite low and used mainly for lighting. The capacity ranges from about 0.7 kW to 2.3 kW. The panel peak rating is 130 W and 265 W. Over 95% of level 3 and 2 hospitals are connected to single-phase power lines, hence they cannot be used to run some of the diagnostic hospital machines. Solar water heaters, with zero running cost, are crucial, especially in maternity wings, as they are used for heating water for bathing babies. Tables 8, 9, and 10 shows the electrification status of health facilities in Kilifi County.

a) Level 5

Kilifi has two level 5 hospital namely: Malindi Sub-county Hospital and Kilifi County Referral Hospital. These hospitals are connected to three phase power line and a generator for back up. The hospitals have also installed a solar water heater. In addition, Malindi Sub-County hospital has also installed a functional 200KW solar PV system.

b) Level 4 Hospitals

Kilifi county has a total of 8 level four hospitals, also called sub-county hospitals (SCH). The facilities' electrification status is as summarised in Table 18.

Table 18: Electrification Status of Level 4 Hospitals

Sub-county	Facility	Main source of power	Back up power supply	Solar Water Heating system
Ganze	Bamba SCH	KPLC—Three phase	Solar & Genset	None
Kilifi South	Mtwapa SCH	KPLC—Three Phase	None	None
Magarini	Marafa SCH	KPLC—single phase	Generator (small portable)	None
Rabai	Rabai SCH	KPLC—Three phase	Solar—maternity	Installed –maternity
Kaloleni	Mariakani SCH	KPLC—Three phase	Generator	Installed
	Jibana SCH	KPLC—Three phase	Generator	None
Kilifi North	Gede SCH	KPLC—Single phase	None	None
	Mida SCH	KPLC—single phase	Genset	None

c) Level 3 Hospitals

Kilifi county has 15 level 3 hospitals (Health Centres).

Table 19: Electrical Status of Level 3 Hospitals

Sub-county	Facility	Main source of power	Back up power supply	Solar Water Heating
Ganze	Vitengeni	Single phase KPLC	Solar PV	None
	Ganze	Single phase KPLC	None	None
	Jila Model	Single phase KPLC	None	None
	Mbudzi	Single phase KPLC	Genset	None
Kilifi South	Vipingo	Single phase KPLC	Genset	None
	Kizingo	Single phase KPLC	None	None
	Chasimba	Single phase KPLC	None	None
Magarini	Gongoni	Single phase KPLC	None	None
	Garashi	Single phase KPLC	None	None
Rabai	Chilodi Crossfit	Solar PV (on-grid)	N/A	None
	Bwagamoyo	KPLC	None	None
Malindi	Muyeye	Single phase KPLC	Solar PV (Defective)	Installed
	Baolala	Single phase KPLC	Solar PV (Defective)	None
Kaloleni	Gotani Model	3-phase KPLC	Genset	None
Kilifi North	Matsangoni	3-phase KPLC	Genset	None
	Mida	Single phase KPLC	Genset	None

Source: (County Government of Kilifi, March 2024)

d) Level 2 Hospitals

Kilifi county has 123 level 2 hospitals (Dispensaries). 10 of these hospitals are not connected to electricity.

Table 20: Electrical Status of level 2 Hospitals

Sub-county	No. of operational facilities	No source of power	Mainly powered by KPLC		Mainly powered by solar PV		No. of facilities with defective PV systems	With Solar Water Heating system
			With PV back up (a)	Without power back up	On-grid (b)	Off-grid (c)		
Ganze	21	1 (off-grid)	6	4	5	5	5 (3b+2c)	0
Kilifi South	9	0	1	7	1			0
Magharini	35	0	4	15	8	8		0
Rabai	12	0	4	5	3			0
Malindi	14	4 (on-grid)		10				0
Kaloleni	13	4 (3 on, 1 off-grid)		9				0
Kilifi North	19	1 (on-grid)		17		1		0
Totals	123	10	15	67	17	14	5	0

Source: (County Government of Kilifi, March 2024)

3.2.4.3 Trade Centres

Trade centres refer to urban areas where the exchange of goods and services occurs. Kilifi County targets to install street lights and floodlights in the markets and streets of all its trading centres to enhance security, safety, and promote trading activities around the clock, 24/7. Connecting electricity to trading centres promotes their growth by attracting investors and modernization, leading to urbanization. The installation of streetlights improves security and enables businesses to extend their working hours.

3.2.4.3.1 Trading Centres [streets and markets (roofed and open air market)]

Trading centres in this context refers to a place where retailing of goods (food stuff, clothes, utensils clothing, livestock are sold). They provide revenues to the county government through levies on trading activities. The market could be a roofed structure or open-air markets. According to the Directorate of Trade and Energy report 2024, Kilifi County has a total of 89 markets out of which 53 are open air markets. Of the 89 markets 65 are electrified which represents 66.3%. Some of the markets are connected to the national grid while others are installed with high most Solar PV lighting systems, Table 21 shows the electrification status of Trading Centres/Markets as per report on energy project implemented between 2019–2022 in Kilifi County.



Table 21: Electrification status at Trading Centres/Markets as per 2019 Report

Sub-county	Electrified Status of Markets (Open and Closed)			Total	Electrification %
	Grid Connected	Solar	Non-Electrified		
Ganze	1	1	8	10	20
Kaloleni	13	4	2	19	89.5
Kilifi North	10	2	3	15	80
Kilifi South	7	1	4	12	66.7
Rabai	3	1	2	6	66.7
Malindi	11	4	5	20	75
Magarini	2	2	2	6	66.7
Total	55	10	26	89	66.3

Source: Directorate of Energy and Trade – Kilifi County 2024

3.2.4.3.2 Trading Centres (Street Lights and High Mast Floodlights in Public Places)

A street light, light pole, lamppost, street lamp, light or lamp standard is a raised source of light on the edge of a road or path. Floodlights are great lighting fixtures that emit a broad beam of light. They keep outdoor spaces very well lit and, as a result, much safer. The height of street lights and High Mast Floodlights range between 6–15 metres and 15–40 metres (FUTAO METAL, 2020) respectively.

Street lights and floodlights are installed mainly for security and clear view of objects for comfortable movement. Some of the social benefit of the programme include: Improved security in the areas targeted, supports economic activities in the targeted areas by increasing working hours for the businesses, and improves the quality of life. Article 3(b), section B on the function of the county government under the fifth schedule of the Kenya Energy Act 2019 states that the County Governments are responsible for provision and maintain adequate street lighting. Kilifi County Government has installed street lights and high mast floodlights, both grid connected and standalone solar PV systems. Kilifi County has installed a total of 55 streets with street lights (24 solar PV and 31 Grid connected) and 223 high mast lighting systems (166 grid connected and 63 Solar PV). Table 22 shows the street lights and high mast floodlights installed in Kilifi County.

Table 22: Summary of Energy Public Places Lighting Project Installed Between 2019 to 2021

Sub-County	Solar Highmasts	Solar Streetlights	Double Pole Solar Streetlights	Grid Highmasts	Grid Streetlights
Kilifi South	9	40	-	1	-
Kilifi North	12	54	-	1	-
Malindi	9	18	-	-	-
Magarini	21		-	6	-
Kaloleni	5	8	5	-	-
Rabai	6	-	-	2	-
Ganze	4		2	1	-
Grand Totals	66	120	7	11	-

Source: (County Government of Kilifi, March 2024)

3.2.4.4 Micro, Small, and Medium Enterprises (MSMEs)

Micro enterprises are businesses with fewer than 10 employees; small enterprises have 10–49 employees, while medium enterprises have 50–99 employees. MSMEs in Kilifi can be found in various sectors, including manufacturing, retail, and professional services. In manufacturing, MSMEs produce products such as clothing, food and beverages, textiles, and household items. In Kilifi County, 29.8% of households engage in MSMEs as their primary source of income (Kilifi County—SETA Team, March 2023). According to a 2022 Kenya Power report, 6,463 MSMEs in Kilifi County were connected to the national electricity grid. Depending on the size and type of services provided, MSMEs require single-phase or three-phase electrical power supply. Majority of SMEs (Jua kali) sector lack capital to acquire modern equipment, tools and machinery to improve their productivity and may affect the quality products produced. Some of the MSMEs based in remote areas have no electricity or the electricity available is single phase hence it cannot power heavy machinery.

3.2.4.5 Water Sources Supplying Water for Consumption

1. Boreholes

According to data provided by the county department of water access, there are a total of 52 existing boreholes in the county. Encouragingly, 49 out of the 52 boreholes are already fitted with water pumping infrastructure. Out of these 49 boreholes, 47 are fitted with solar-powered pumps, while 2 are fitted with grid-powered pumps. According to the directorate of water access, water pumping power supplied by the existing pumping infrastructure in the 49 boreholes is sufficient. It's only 3 boreholes therefore which need water pumping solutions. These 3 boreholes are profiled as follows;

Table 23: Profile of 3 Boreholes

Sub-county	Name	On grid/ off-grid	Average Daily water demand (liters)	Average Yield (liters/ hour)	Daily Pumping duration (hours)	Desired pump capacity (kW)	Desired capacity of elevated tank in liters	Management
Kilifi North	Kibarani	On-grid						Communal
Magarini	Makumba	Off-grid						Communal
Malindi	Kwa Upanga	Off-grid						Communal

2. Communal Water Pans (names and more details in the annex)

As per data provided by the county directorate of water, there are a total of 20 communal water pans in the county which primarily supply water for human and livestock consumption. The water holding capacity is unknown. Water lifting head is also unknown. Average daily water demand at each pan is estimated at 20,000 litres. All of them are in off-grid areas. It's proposed to equip all the pans with solar pumping infrastructure.



3. Municipal water pumping (KIMAWASCO)

Region	Number	Water Pumping Technology					
		KPLC	Diesel	Solar	KPLC/Solar	KPLC/ diesel	KPLC/ solar/ Genset
Chonyi	7	5	1		1		
Baricho	3	2	1				
Ganze	6	1	2	1		1	1
Kaloleni	6	6					
Kilifi	3	3					
Mariakani	6	4	2				
Mazeras	2	2					
Mtwapa	2		2				
Vitengeni	3		1	2			
Total	38	23	9	3	1	1	1

Category 3: Municipal water pumping (KIMAWASCO)

Pumping technology	No. of pump stations	Grid/ transformer Proximity	Average Pump capacity (kW)	Pump type	Average lifting head (m)
Grid	23	N/A	10–45	Surface	154–275
Diesel	9	>600	22	Surface	177–247
Solar	3	>600	7.5	Surface	18–37
KPLC/Solar	1	N/A	22	Surface	22–45
KPLC/ diesel	1	N/A	18.5 *4	Surface	
KPLC/ solar/ Genset	1	N/A	18.5 *4	Surface	
	38				

3.2.5 Pathways for Universal Electricity Access

All the analysis conducted using a GIS developed specifically for Kilifi County electrification plan. In order to obtain the greatest accuracy, a set of **374 population clusters were defined** using a continuous raster surface representing the population density of the County. Population estimates for both rural and urban clusters were then cross checked with the population data of the last census (2019). Electrification status of clusters was defined based on the location of step-down transformers through a GIS layer provided by KPLC and then cross-checked with the County representatives. Clusters that are located fully or partially within a 600m buffer around transformers (maximum distance at which households are generally located from transformers) were considered ‘electrified’. Clusters that didn’t overlap with the buffer were considered unelectrified. The following are different supply pathways (options) proposed for universal access:

- Grid Densification**—to connect unelectrified households in already electrified cluster
- Grid Intensification**—to electrify housing clusters within a perimeter between 601 to 1,500 metres from an existing transformer

- iii. **Grid Extension**—consisting in extending the interconnected grid to the clusters in unserved areas;
- iv. **Mini-Grids (both PV and hybrid)**—deployed in small and medium-sized clusters located far from the interconnected network

a) Solar PV powering for small residential settlements

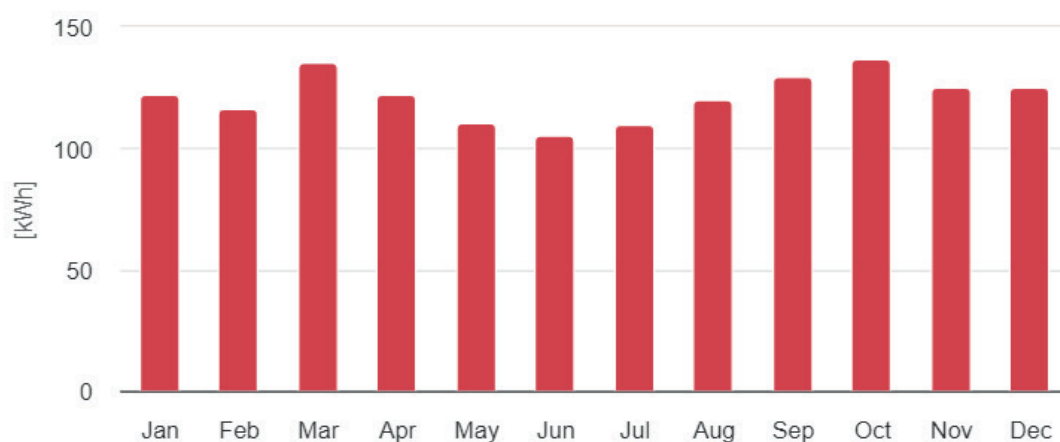
This small residential PV system could vary in terms of its capacity in kWp (100 Wp to 1 kWp) and how it will be used, however a typical small system of 0.1 kW solar system will generate about 13 kWh of electricity per month. This is enough to power a few home appliances, including your fridge, TV, light bulbs, and a fan (depending on how much energy your unit uses)⁴.

Investment costs for smaller systems are still high, in the range of 10–12 USD/Wp installed, typically for a 50 Wp system a cost of 60 to 70 USD or 80,000 to 100,000 Kes. However, the replacement of the battery pack may be expected after 5 to 8 years at a cost of 40 to 50,000 KES.

Figure 26: Monthly production averages for 100 Wp installed in Kilifi

Monthly averages

Total photovoltaic power output



The PV production is almost constant during the year, with April, June, and November showing a production below the average.

⁴ EcoWatch (2023). Will a 3 kW Solar Panel System Work for Your Home? – Retrieved from: <https://www.ecowatch.com/solar/3-kw-solar-systems#:~:text=A%203kW%20solar%20system%20will,much%20energy%20your%20unit%20uses>). Date: 8/9/2023



b) Solar plants for SME and factory

The average high solar resource and its equally distributed potential during the year make this resource economically interesting for larger SMEs and factories with significant electricity demand per year (tea factories, dairies, cooling facilities).

The total investment costs for utility-scale solar PV capacity have dramatically decreased during the past 10 years⁵. The cost of PV panels in 2022 was around 0.307 USD/W_p for mainstream PV panel production. The cost of the highly efficient panels was 0.407 USD/W_p and for low-cost technology down to 0.993 USD/W_p.

The low cost of the panels led to a significant fall in the global capacity-weighted average total installed cost of utility-scale projects commissioned in 2022 to:

- USD 876/kW (4% lower than in 2021 and 83% lower than in 2010).
- With a range from USD 569/kW to USD 1 878/kW for all projects within the 5th and 95th percentile.
- The cost of utility-scale PV projects for South Africa is 1,257 USD/kW_p installed.

It is reasonable to assume that the investment costs of a solar power plant for industrial uses, with installed capacity ranging from a few MW to 10 MW, could be installed in Kenya for 1,200 to 1,400 USD/kW_p (system without storage, synchronized to the KP supply).

With a capacity factor of 17.5% and a total system efficiency of 90%, the Levelized Cost of Electricity (LCOE) for a 20-year investment could range from 17.0 to 19.8 KES/kWh⁶ compared to the current tariff of 23 KES/kWh paid to Kenya Power.

The internal rate of return (IRR) on the investment will range from 11% to 13%, and the investment could be repaid after 7 to 8 years.

c) Solar potential for thermal applications

i. Solar Water Heating (SWH)

- The Solar Water Heating Regulations (2012) were developed by the then Energy Regulatory Commission under the Energy Act No. 12 of 2006. This regulation's objective was to promote the uptake of SWH solutions in industrial, commercial, and residential buildings. The expected benefits of this regulation were,
 - ▶ enhanced national energy security through diversification,
 - ▶ reduced demand during peaking hours which results in avoiding expensive fossil fuel-powered plants,

⁵ IRENA (2023), Renewable power generation costs in 2022, International Renewable Energy Agency, Abu Dhabi

⁶ SETA economist own assessment



- ▶ increased environmental protection through a reduction in greenhouse gases (GHG), and
- ▶ increased employment, technical capacity, and income from an expanded SWH industry⁷.
- These regulations make it mandatory for all premises (within the jurisdiction of a local authority) with hot water requirements exceeding one hundred liters per day to install and use solar water heating systems. Today, one of the objectives for installing a solar water heater for the end-users is to reduce their electricity bills.

Based on an average Global Horizontal Irradiation of 20.5 MJ/m²/day, a square metre of solar water heater will be able to heat 60 liters of water from 10 to 60 °C for an SWH with an efficiency of 60% or 80 liters if the efficiency is around 80% (detail: $20.5 \text{ MJ/m}^2 \times 1,000 \text{ (MJ/kJ)} \times 60\% \text{ (efficiency)} / (4,18 \text{ KJ/l/}^\circ\text{C} \times \Delta 50^\circ\text{C})$).

- The size of an SWH to heat 1 m³ of water from 10 to 60 °C could vary from 14 m² for highly efficient equipment to 17 m² for standard equipment (60% efficiency).
- To heat one m³ of water to 60°C using an electrical water heater, the energy consumption is estimated at 232 GJ or 64 kWh (detail: $1,000 \text{ l} \times 4,18 \text{ kJ/l/}^\circ\text{C} \times 50^\circ\text{C} / 90\% \text{ (efficiency)}$).

ii. Solar Drying

Drying agricultural produce using solar energy can improve value addition of products and act as a preservation technique for both plant and animal products like meat.

This study⁸ illustrates the pros and cons of using a solar dryer to dry pyrethrum in some parts of Kenya, including Kilifi (if relevant or other cash crop requiring a drying process). Challenges include high procurement costs and inability to work during the rainy season. However, its benefits include speeding up the drying process during hot seasons, reducing waste, and improving yield value due to longer shelf life, hence meeting the needs of export markets. In addition, auxiliary power sources can be included to enable operation during the rainy season.

A more recent example is the solar tunnel drier⁹, tested in Isiolo, which can dry and preserve meat for up to a year. It enables livestock farmers to dry meat produce faster than traditional techniques like sun drying, adding value to meat products and reducing losses. Besides meat, it can be used to dry vegetables, fruits, herbs, and cereals like maize.

With the high solar potential in Kilifi, these solutions could be explored and tested if relevant.

iii. SWH preheating of hot water and low-pressure steam for process energy

Dairies, thermal food processing factories, and slaughterhouses generally use firewood to meet their hot water or low-pressure steam needs for cleaning their installations and pipes and as process energy (e.g., milk pasteurization).

Efficient SWHs could be installed to preheat the water supply to boilers, reducing the primary fuel needed. The preheater is effective during daylight hours from 10 am to 4 pm.

⁷ EED Advisory (2017). STUDY OF THE SOLAR WATER HEATING INDUSTRY IN KENYA. Retrieved from: https://www.solarthermalworld.org/sites/default/files/news/file/2018-10-31/study_of_the_swh_industry_-_kenya_high_res_final.pdf. Date: 8/9/2023

⁸ <https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/20607/IDL-20607.pdf?sequence=1>

⁹ <https://www.standardmedia.co.ke/article/2001298049/solar-tunnel-drier-that-preserves-meat-for-a-year>



3.2.6 Envisioned Progression to Universal Electricity Access

3.2.6.1 Households

The baseline year for electricity access¹⁰ is 2019. The Kilifi County population in 2019 was 1,453,787 (Government of Kenya, KNBS, 2019); approximately 298,472 households for a household size of 4.8. In 2019, the population which had access to electricity was 58.5% (38.5% connected to grid while 20% using distributed electricity solutions (Solar PV)), translating into 174,606 households (Government of Kenya, KNBS Census, 2019). It is more economical to use an off-grid/distributed electricity solution to reach out to the population in remote parts of the county, which do not have access to the national grid. Table 4 shows the electricity access progression.

The county specifically targets to increase the households' electrification rate from the current estimated rate of 58.5% to universal access by 2027. At a mean inter-censal annual growth rate of 3.05% (County Government of Kilifi, 2018), the projected total population and connectivity is as indicated in Tables 24, 25, and 26 for scenarios 1, 2, and 3.

Table 24: Progression Connectivity of HHs to Electricity Connectivity for Scenario 1

Year		2019 (Census)	2022 (Projected)	2025 (Projected)	2027 (Projected)
Projected Population		1,453,787	1,547,747	1,636,510	1,696,226
Projected Number of Households		302,873	322,448	340,940	353,381
% Access grid to electricity projection		38.5	49.1	46.4	44.8
% Access to Solar PV projected		20	32.2	43.8	56.6
Total % access to electricity by Households		58.5	81.3	90.2	100
Number of households connected	Grid Electricity	116,606	158,406	158,406	158,406
	Solar PV	60,575	103,893	149,207	200,060
Total Number of households connected		177,181	262,299	307,613	358,466
New connections	Grid Electricity		41,800	0	0
	Solar PV		41,800	45,314	50,583
Total New connections			84,969	45,378	50,800

¹⁰ Electricity access is defined as the connections (or equivalent when dealing with solar home systems, distributed power or non-metered mini-grids) consistent with the Global Tracking Framework (GTF) and with the multi-tier approach under GTF.

Table 25: Progression Connectivity of HHs to Electricity Connectivity for Scenario 2

Year		2019 (Census)	2022 (Projected)	2025 (Projected)	2027 (Projected)
Projected Population		1,453,787	1,547,747	1,636,510	1,696,226
Projected Number of Households		302,873	322,448	340,940	353,381
% Access grid to electricity projection		38.5	62.6	72.4	72.5
% Access to Hybrid mini-grid projections		0	0	0	0.2
% Access to Solar PV projected		20	18.8	17.8	28.7
Total % access to electricity by Households		58.5	81.4	72.4	100
Number of households connected	Grid Electricity	116,606	201,724	247,038	256,274
	Solar PV	60,575	60,575	60,575	101,398
	Hybrid mini-grids	0	0	0	794
Total Number of households connected		177,180	262,299	307,613	358,466
New connections	Grid Electricity		85,118	0	0
	Solar PV		85,118	45,314	50,583
	Hybrid mini-grid		0	0	794

Table 26: Progression Connectivity of HHs to Electricity Connectivity for Scenario 3

Year		2019 (Census)	2022 (Projected)	2025 (Projected)	2027 (Projected)
Projected Population		1,453,787	1,547,747	1,636,510	1,696,226
Projected Number of Households		302,873	322,448	340,940	353,381
% Access grid to electricity projection		38.5	62.6	72.4	72.7
% Access to Hybrid mini-grids projections		0	0	0	0
% Access to Solar PV projected		20	18.8	17.8	28.7
Total % access to electricity by Households		58.5	81.4	72.4	100
Number of households connected	Grid Electricity	116,606	201,724	247,038	257,068
	Solar PV	60,575	60,575	60,575	101,398
	Hybrid mini-grids	0	0	0	0
Total Number of households connected		177,181	262,299	307,613	358,466
New connections	Grid Electricity		85,118	45,314	10,030
	Solar PV		85,118	45,314	50,583
	Hybrid Mini-Grids		0	0	0

3.2.6.2 Institutions

Kilifi County has a total of 1,525 institutions (Source: Kilifi County GIS Energy Database, Department of Health and Trade—Kilifi County) excluding those managed by the private sector. By 2019, on average, 38.5% of these institutions were electrified. In the progression of electricity connectivity, it is assumed that the number of institutions will remain the same. It should also be noted that due to the country lockdown from March 2020, there was little activity, hence connectivity was negligible. Tables 27 and 28 show electricity connectivity of the institutions increasing from 61.6% in 2020 to 72.1% in 2022.



1. Learning Institutions

Table 27: Projected Yearly Connectivity of Learning Institutions to Electricity

Year	2024	2025	2026	2027
Number new connections for ECDEs per year (number unelectrified 345)	80	85	90	90
Number new connections for Primary Schools per year (number unelectrified 96)	16	30	30	30
Number new connections for Secondary Schools per year (number unelectrified 11)	5	6	0	0
Number Vocational and Technical College (VTC) upgraded from single to 3-phase per year (number of VTC connected to single phase 3)	1	2		
Number new connections to 3-phase for VTC per year (number unelectrified 7)	1	3	3	

2. Health Facilities

Table 28: Projected Yearly Connectivity of Health facility to Electricity

Year	2024	2025	2026	2027
Electricity Access for Level 2 (Dispensaries)				
7 on grid facilities without electricity connected to National Grid Electrical Power	2	3	2	-
17 facilities powered by Solar PV to National Grid Electrical Power	3	4	5	5
2 off-grid facilities without electricity connected to Solar PV	1	1	-	-
14 off-grid facilities with solar PV provided with small genset or the Solar PV upgraded (subject to further evaluation)	2	3	3	3
Provide small genset or solar PV systems to 67 facilities powered by grid power but have no back up power supply.	15	15	17	20
Repairing all defective solar PV systems (reported as 5 but the number could be higher). For purposes of costing, we will work with 25 systems in need of rehabilitation.	10	15	-	-
123 facilities installed solar water heating (SWH) systems	20	30	35	38
Electricity Access for Level 3 (Health Centres)				
Upgrade all the remaining 13 facilities from single phase to three phase	2	3	4	5
Install 11 Electric Power Generator Power back – up in the remaining 11 facilities	2	3	3	3
Electricity Access for Level 4 (Sub-County Hospitals)				
Upgrade all the remaining 3 facilities from single phase to three phase	1	1	1	-
Install 4 Electric Power Generator back up in the remaining facilities	1	1	2	-
Electricity Access for Level 5 (County Referral Hospitals)				
Installation of 500 kW Solar PV back up without batteries	-	1	1	-

3.2.6.3 Urban/Trading Centres' Lighting

3.2.6.3.1 Trading Centres and Markets (roofed and open-air market)

There are 89 markets in Kilifi County, out of which 26 are unelectrified, according to the County Government Directorate of Trade. The progression for the electrification of these 26 is as indicated in Table 29.

Table 29: Progression of Yearly Connectivity of Markets to Electricity – Lighting

Year	2024	2025	2026	2027
Number of Markets Connected	63	6	10	10

3.2.6.3.2 Trading Centres (Street Lights and High Mast Floodlights in Public Places)

Table 30: Progression of Yearly Installation of Streetlights and High Mast Floodlights

Year	2024	2025	2026	2027
Number of Grid connected street lamps installed per year	90	300	300	300
Number of Solar PV power street lamps installed per year	50	100	150	150
Number of Grid connected powered high mast floodlight installed per year	1	2	2	2
Number of Solar powered high mast floodlight installed per year	10	15	20	20

3.2.6.4 Water Sources Supplying Water for Consumption

3.2.6.4.1 Projects– 3 boreholes without source of power

Out of the 52 boreholes existing in the County, only three are unelectrified.

Table 31: Progression of Yearly Installation of Electric Water Pumps in Boreholes

Project	No. of boreholes Targeted	2024	2025	2026	2027
Installing solar-powered pumping infrastructure with hybrid AC/DC pumps	2	1	2	-	-
Installing grid-powered pumping infrastructure (hybrid AC/DC pumps)	1	1	-	-	-

3.2.6.4.2 Communal Water Pans (names and more details in the annex)

There are a total of 20 communal water pans in the county, which primarily supply water for human and livestock consumption. All of them are in off-grid areas. It's proposed to equip all the pans with solar pumping infrastructure. It is proposed to equip all the pans with solar pumping infrastructure. Since the water holding capacity and the lifting head are unknown, it is recommended that the Directorate of Energy commission a feasibility study on installing solar water pumping infrastructure on these 20 water pans. The study will inform the county government on the feasibility of installing electrical water pumping infrastructure on these facilities.

Table 32: Progression for Feasibility Studies for Installation of Solar PV Water Pumps to 20 Communal Water Pans

Year	2024	2025	2026	2027
Number of Feasibilities studies per year	4	5	5	6

3.2.6.4.3 Municipal water pumping (KIMAWASCO)

Kilifi Mariakani Water And Sewerage Company Limited (KIMAWASCO) has installed a total of 38 water pumping stations of varying capacity across its water supply network. 23 stations are connected to the grid, 9 to diesel generators, and 3 to Solar PV. One station is connected to the grid and has a solar



PV backup pump, and another grid-connected station has a diesel generator backup pump. There is also another station connected to the grid with both solar PV and diesel generator backup. KIMAWASCO plans to replace its diesel pumps with Solar PV pumps and systematically solarise all its pumping stations. Installing a solar PV system will reduce the heavy bills incurred by KIMAWASCO for grid-connected and generator-powered stations, besides reducing greenhouse gas emissions. Table 33 shows the progression for solarisation of KIMAWASCO water pumping stations. Priority will be given to 9 pumps connected exclusively to diesel generators.

Project/ solutions:

- Installing solar pumping infrastructure at the 9 pumping stations exclusively pumping with diesel.
- Installing solar pumping infrastructure at the 23 pumping stations pumping with grid power (subject to confirmation of power bills incurred).

Table 33: Progression of Yearly Installation of Solar PV Pumps for KIMAWASCO Water Pumping Stations

Year	2024	2025	2026	2027
Number of pumps connected to Solar PV per year	6	8	9	9

3.2.7 Estimated Investments in Energy Access to Electricity

3.2.7.1 Households

County was used to analysis to analysis the access to electricity. The access status was defined based on the location of step-down transformers through a GIS layer provided by KPLC and then cross checked with the county representatives.

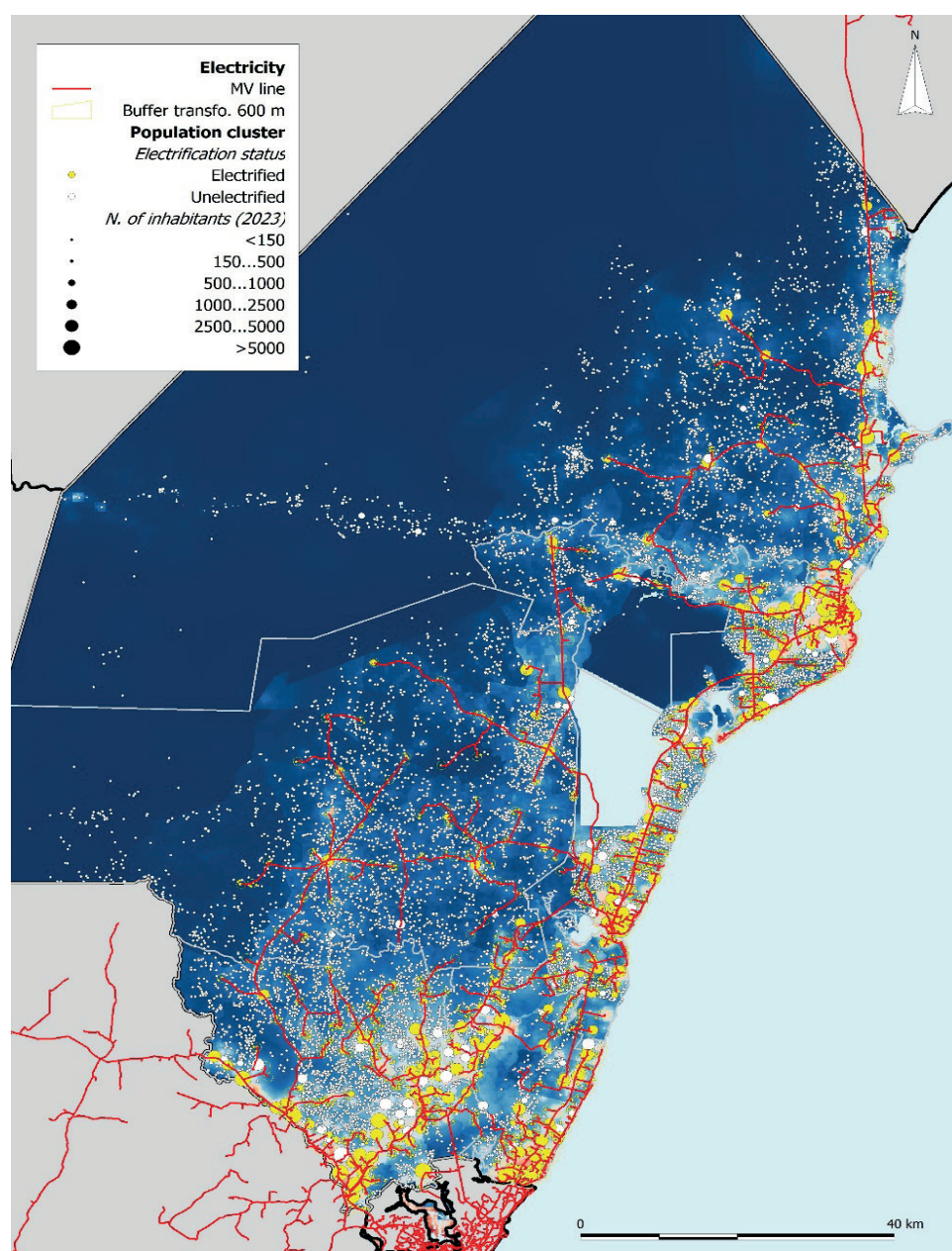
The choice of the best electrification option is made according to the LCOE: the ratio between the lifetime costs divided by the electricity production of a project. For conventional electrification solutions like grid or mini-grid connections, as the size of the localities and the level of consumption increase (from Tier 1+ to Tier 5), the LCOE decreases. The LCOE of Solar Home Systems (SHS) does not change insofar as these solutions are individual.

Using these population clusters as a starting point, the geospatial electrification tool GEOSIM was used to calculate the investments and operating costs related to universal access to electricity. The choice of the best electrification option is made according to the lowest LCOE. The investment for each electrification pathway, as well as the OPEX costs were calculated from the current costs of equipment in Kenya.

- Grid expansion, intensification & densification
- Setting up of mini-grids
- Deployment of solar home systems;
- Flexible repayment plans
- Affordability—tariffs, connection fees



Figure 27: Map of Electrification Status of Population Clusters



To look across the spectrum of electricity demand, three scenarios corresponding to different levels of consumption (Tiers) were tested for rural and urban areas in order to quantify the investment required and identify the best electrification option for every community across Kilifi County. The geographically dispersed population is divided into small units of analysis referred to as “population clusters” of which 89% have fewer than 150 inhabitants, 7% between 150 and 500 inhabitants, and 4% between 500 and 20,000 inhabitants.

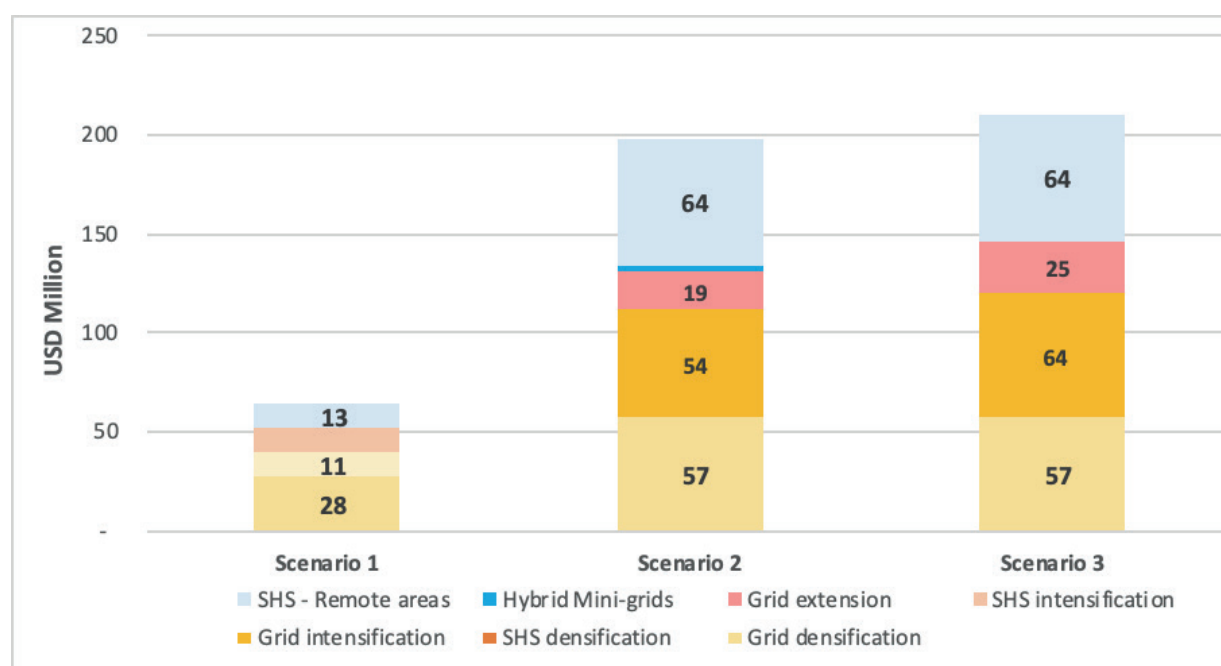
As indicated in Table 34, consumption levels range from Tier 1+ (task lighting and phone charging) to Tier 5 (allowing the use of high-load appliances such as laptops, fridges, washing machines, iron, hair dryers, toaster or microwave, air cooler and small business operations—productive use of energy).

Table 34: Energy Consumption Scenarios Explored for the Least-Cost Electrification Planning

Scenarios	Tiers	Attributes			
		Quantity (peak available capacity)	Duration of supply (hrs)	Evening Supply	Quality (voltage)
1	Tier 1	>1W	>4	>2	-
	Tier 2	>50W	>4	>2	-
2	Tier 3	>200W	>8	>2	Adequate
3	Tier 4	>2,000 W	>16	>4	Adequate
	Tier 5	>2,000 W	>22	>4	Adequate

Considering the 196,000 households already electrified, this means that **181,000 households need to be electrified** to achieve universal access. As shown in Figure 4, total investment for achieving this objective varies greatly between Scenario 1 and Scenarios 2 & 3.

Figure 28: Summary of investments by scenario for universal access in the County



In the highest scenario (Scenario 3), electrification will mainly take place through the development of the existing network. In this scenario, 78% of households will be electrified by grid connection (47% via grid densification, 25% by grid extension, 6% via grid intensification). SHS deployment in remote areas will cover the remaining 23%. **This scenario requires an investment of USD 210.5 million.**

The intermediate scenario (Scenario 2) is quite similar to Scenario 3. Most electrification will be on-grid through densification and intensification, as well as SHS deployment in smaller and less populated areas. Twelve localities (600 inhabitants on average) were identified as suitable for hybrid solar mini-

grids rather than for the extension of the interconnected network (see map 3)¹¹. **The total investment for universal access to electricity in Kilifi County was estimated at USD 198.5 million.**

Table 35: Investment by Scenario and Supply Option

Supply option	Scenario 1	Scenario 2	Scenario 3
Grid densification	28 089 600	57 199 296	57 199 296
SHS densification	11 392 634	-	-
Grid intensification	-	54 376 800	63 530 228
SHS intensification	11 917 582	-	-
Grid extension	-	18 969 981	24 969 585
Hybrid Mini-grids	-	3 196 253	-
SHS—Remote areas	13 374 339	64 826 924	64 826 924
Total	64 774 155	198 569 254	210 526 033

Investment for County's **electrification plan changes drastically for Scenario 1** compared to the other two scenarios. In Scenario 1 (**USD 64.7 million**), only urban households in densification areas would be electrified via the national grid due to their expected high level of consumption (Tier 5). All other households (77%) would be connected through SHS.

Table 36: Number of New Connections by Supply Option and Scenario

Supply option	Scenario 1	Scenario 2	Scenario 3
Grid densification	41 800	85 118	85 118
Sharing (%)	23	47	47
SHS densification	43 318	-	-
Sharing (%)	24	-	-
Grid intensification		45 314	45 314
Sharing (%)	-	25	25
SHS intensification	45 314	-	-
Sharing (%)	25	-	-
Grid extension		9 236	10 030
Sharing (%)	-	5	6
Hybrid mini-grids		794	-
Sharing (%)	-	0	-
SHS—Remote areas	50 853	40 823	40 823
Sharing (%)	28	23	23
Total	181 285	181 285	181 285

¹¹ The 2018 KNES creates a 15 km buffer zone around MV infrastructure where mini-grids cannot be deployed. In this context, only the electrification project of Watamu Island as well as projects n°4632 and n°19066 in Adu Ward (see the tabulation for supply option in Excel file) could be candidate for solar mini-grids. Notwithstanding, this regulation should change in the 2024 KNES in order to provide flexibility and increase rural electrification.



Figure 29: Map of Electrification planning of the County—Scenario 3

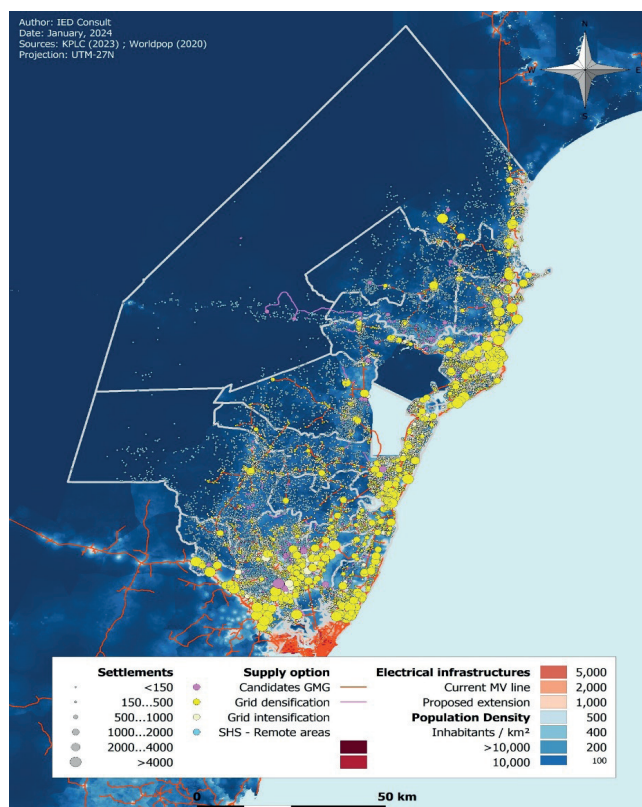


Figure 30: Map Electrification planning of the County—Scenario 2

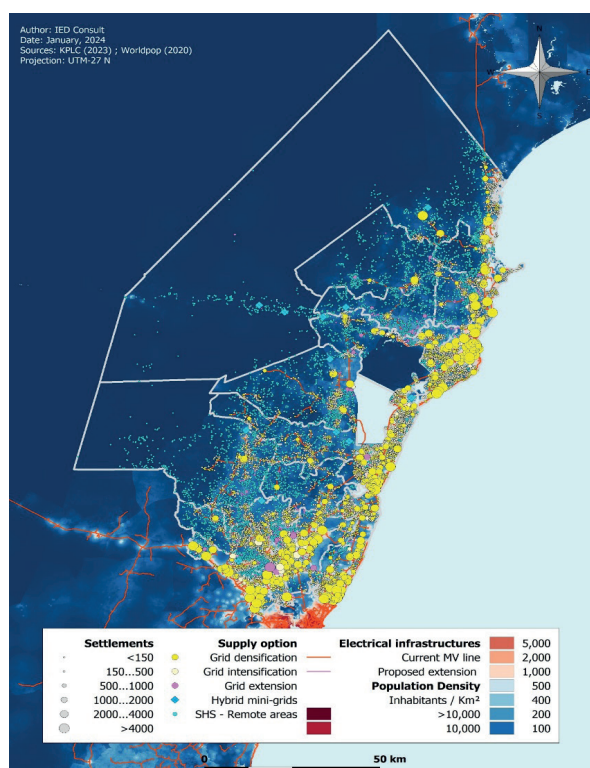
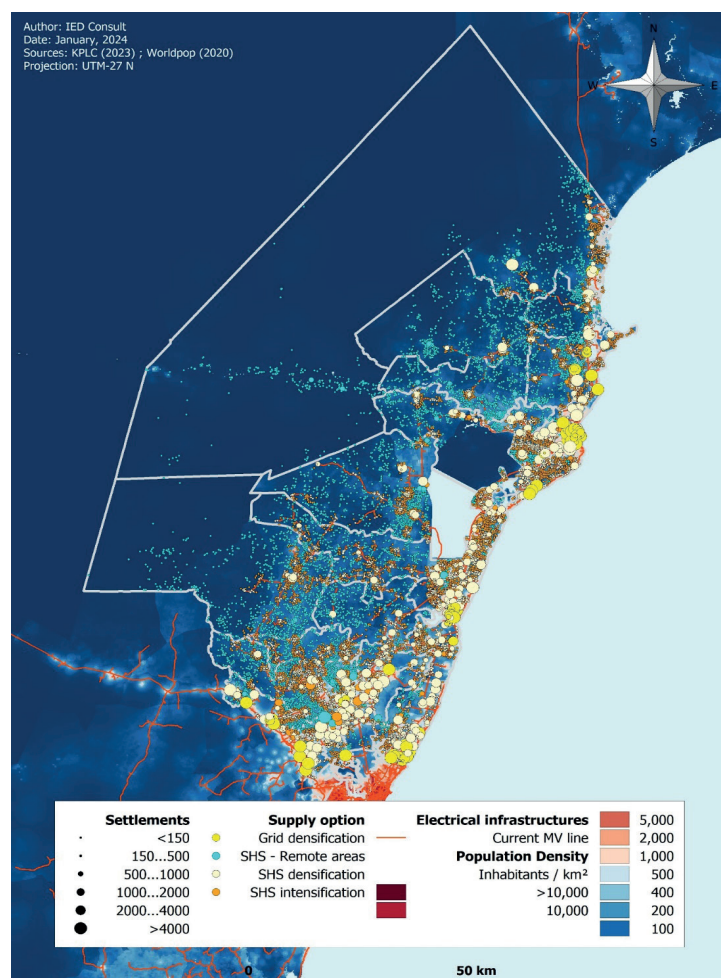


Figure 31: Electrification planning of the County—Scenario 1



Since 2004, the electricity connection price for a household within 600 metres of a transformer was set at USD 398 (35,000 KES). This usually includes two poles, a meter, and the service line. However, KPLC estimates the full cost for a single connection at USD 1,435. Since 2015 and the launch of the Last Mile Connectivity Project (LMCP) this price has been lowered to USD 171 (15,000 KES) thanks to the support of the World Bank and the African Development Bank. However, in 2019, a study conducted by Lee & all¹² showed that only 23.7 percent of rural households would take-up even at a similar connection price.

Results of this electricity planning for Kilifi County show that connection costs should be higher than KPLC's estimates, especially for rural areas. A high level of subsidy for connections to isolated households should remain significant.

Whether electrification takes place via the interconnected network, mini-grids, or SHS, it is important to generalize access through funded installation payments, allowing consumers to repay the connection through monthly or daily payments. Such solutions already exist (e.g., M-kopa Solar) and reduce upfront costs. In Scenario 1, connection costs would involve a daily payment of KES 50 for two years, with a

¹² LEE K., MIGUEL E., WOLFRAM C., "Experimental Evidence on the Economics of Rural Electrification" in *Journal of political economy*, Volume 28, Number 4, April 2020.

deposit of KES 6,000. For a grid connection in urban areas, the same payment would have to be paid for 3 years with a deposit of KES 10,000.

Table 37: Summary of Connection Cost in USD to Supply A Single Household

	Scenario 1	Scenario 2	Scenario 3
Densification (urban / rural)	672 / 263	672 / 1041	672 / 1100
Intensification	263	1 200	1 402
Extension		2 054	2 489
Hybrid mini-grids		4 026	-
PV SHS	263	1 588	1 588

The unit cost of electricity could also be a significant obstacle to some households' willingness to connect. Currently, base power prices range from USD 0.086 to 0.11 per unit for low consumption of less than 30–100 units, but simulations predict prices above USD 0.18 in Scenario 3, or over USD 0.50 in Scenario 2.

N/B

In this plan, we have identified opportunities to achieve universal access by 2030 in Kilifi County. The investment required for each scenario is based on a 100% household connection rate, which implies around 26,000 new connections per year. **This objective is very ambitious**, particularly in relation to the ability of rural households to finance their connection, and also because the connectivity rate envisaged in the medium term is always overestimated by decision-makers.

Given the level of the connection costs involved for households, their demand and the current connectivity rate, despite subsidies, it does not seem appropriate to continue the electrification of the County following the Scenario 3. A combination of Scenario 2 (network intensification in peri-urban areas) and Scenario 1 (SHS deployment in rural areas) seems more realistic, provided funded installation payment systems are implemented between the County and REREC. In any case, priority for the electrification of the County should be given to localities where social infrastructures remain unelectrified.



3.2.7.2 Institutions

3.2.7.2.1 Learning Institutions

The investment in learning institution for universal access to electricity is as indicated in Table 38.

Table 38: Costing of Proposed Electrification Solutions for Learning Institutions

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
Connecting ECDEs to grid power	Single phase	300,000	135	40,500,000
Solar PV systems for ECDEs which are off-grid	3–5 kW An average of 7\$/W (IRENA 2016 & previous experiences in the county while implementing similar projects) Exchange rate—(130–150 KES/ \$)	4,000,000	210	840,000,000
Connecting primary schools to grid power	Single phase	300,000	38	11,400,000
Solar PV systems for primary schools which are off-grid	3–5 kW An average of 7\$/W (IRENA 2016 & previous experiences in the county while implementing similar projects) Exchange rate—(130–150 KES/ \$)	4,000,000	58	232,000,000
Solar PV systems for secondary schools which are off-grid	3–5 kW An average of 7\$/W (IRENA 2016 & previous experiences in the county while implementing similar projects) Exchange rate—(130–150 KES/ \$)	4,000,000	11	44,000,000
Upgrading grid supply to 3-phase at VTCs	Three phase	500,000	3	1500,000
Connecting 7 VTC the electricity grid (3 – phase)	Three phase	500,000	7	2100,00
Total				1,169,400,000

3.2.7.2.2 Health Institution

1. Level 2

Table 39: Costing of proposed electrification solutions for level 2 hospitals

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
Grid connection to on-grid 8 dispensaries	Single phase	300,000	8	2,400,000
Solar PV systems for 2 off-grid dispensaries	3–5 kW (An average of 7\$/W (IRENA 2016 & previous experiences in the county while implementing similar projects) Exchange rate—(130–150 KES/ \$)	4,000,000	2	8,000,000
Grid connection to the 17 on-grid dispensaries but powered by solar PV	Single phase	300,000	17	5,100,000
Small Gensets or upgrading PV systems in 16 dispensaries	Solar PV system /30 kVA genset	1,500,000	16	24,000,000
Small Gensets or PV back ups in 75 dispensaries	30 kVA genset	1,500,000	75	112,500,000



Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
Repairing defective PV systems	30% of the initial cost of a PV system—IRENA 2016)	1,200,000	15	18,000,000
SWH systems	2 SWHs, 200 liters systems to cater for maternity, Accessories including: • Elevated tank • Plumbing works • Labor	3,000,000	123	369,000,000
Total cost				539,000,000

2. Level 3

Table 40: Costing of Proposed Electrification Solutions for Level 3 Hospitals

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
Connecting Chilodi Crossfit to grid	Single phase	300,000	1	3,000,000
Repairing the 2 defective PV systems	30% of the initial cost of a PV system—IRENA 2016)	1,200,000	2	2,400,000
Power back systems	30 kVA genset	1,500,000	10	15,000,000
SWH systems	2 SWHs, 200 liters systems to cater for maternity, Accessories including: • Elevated tank • Plumbing works	3,000,000	16	84,000,000
Total cost				104,400,000

3. Level 4

Table 41: Costing of Proposed Electrification Solutions for Level 4 hospitals

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
Upgrade to 3-phase	3-phase	500,000	2	1,000,000
SWH systems	2 SWHs, 200 liters systems to cater for maternity, Accessories including: • Elevated tank • Plumbing works	3,000,000	6	18,000,000
Power back systems	30 kVA genset	1,500,000	3	4,500,000
Total cost				23,500,000

4. Level 5

Table 42: Costing of Proposed Electrification Solutions for level 5 hospitals

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
Grid complementary solar PV systems	500 kW Solar PV plus 500 kW off-grid inverter An average of 7 \$/W (IRENA 2016 & previous experiences in the county while implementing similar projects) Exchange rate—(130–150 KES/ \$)	50,000,000	2	100,000,000
Energy audits	According to KS ISO 50002	2,000,000	2	4,000,000
Total cost				104,000,000

3.2.7.3 Urban/Trading Centres

3.2.7.3.1 Market Electrification

26 markets require electrification. Since the number of the markets on grid and off-grid has not been confirmed, the costing is based on the assumptions that all the 26 markets are off-grid. The budget for off-grid can comfortably accommodate the budget requirement for those markets that will be found to be on-grid.

Table 43: Costing of Proposed Electrification for Markets

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
Solar PV systems for 26 markets	3–5 kW An average of 7\$/W (IRENA 2016 & previous experiences in the county while implementing similar projects) Exchange rate—(130–150 KES/ \$)	4,000,000	26	104,000,000
Total				104,000,000

3.2.7.3.2 Installing Street Lights and High Mast Floodlights in Public Places

1. Grid powered street lights
2. Solar powered street lights
3. Solar powered high mast floodlights
4. Grid powered high mast floodlights
5. Allocating a budget for rehabilitating all faulty street lights and high mast flood lights

Table 44: Costing of proposed electrification for Public Spaces Lighting

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
Grid powered street lights	9 m concrete/steel pole with 80 W led lump, contactor, photocell, and transformer	150,000 (usually cost a half the prize of solar)	990	148,500,000
Solar powered street lights	9 m steel pole with 80 W led lump, gelled battery 80AH/12V, MPPT Controller 15A/24V and 120 W/18V solar panel	315,000 (estimated from Kilifi County procurement prices)	450	141,750,000
Solar powered high mast flood lights		2,500,000	7	17,500,000
Grid powered high mast flood lights	25 m high with 12 lamps of 80 W	4,000,000	65	260,000,000
Rehabilitating all faulty street lights and high mast flood lights				30,000,000
Total				597,750,000



3.2.7.4 Water Sources Supplying Water for Consumption

1. Solutions and costing—boreholes without power

Solution/ project: Installing solar water pumps at Makumba and Kwa Upanga boreholes and a grid powered pump at Kibarani borehole.

Table 45: Costing of Proposed Solar PV Electrification for Boreholes for Supply of Consumption Water

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
Installation of solar water pumping systems: • Site assessment, planning & design • Pumping system installation and commissioning • Training and Capacity Building	Average demand—60–300 72m ³ /day Average yield—5–72m ³ /hour Pump capacity—7.5 to 30 kW	7,000,000 (Cost based on previous similar projects implemented by the Taita Taveta county)	2	14,000,000
Grid powered pumping infrastructure (hybrid AC/ DC pumps)	3-phase	7,000,000	1	7,000,000
General annual maintenance (a quarter of them)		100,000	13	1,300,000
Total				22,300,000

2. Communal Water Pans (names and more details in the annex)

Table 46: Feasibility to Establish the Viability of Installing Solar Water Pumping infrastructure on the Water Pans

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
Feasibility studies	To establish the viability of installing water pans with solar PV pumps infrastructure	300,000	20	6,000,000
Total				6,000,000

3. Municipal water pumping—Solutions and costing

Cost sharing formula

Table 47: Costing of Proposed Solar PV Pumps for Municipal Water Supply Pumping Stations

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
Installation of solar water pumping systems: • Site assessment, planning & design • Pumping system installation and commissioning • Training and Capacity Building	Average demand—60–300 72m ³ /day Average yield—5–72m ³ /hour Pump capacity—7.5 to 30 kW	7,000,000 (Cost based on previous similar projects implemented by the county)	32	224,000,000
Total				224,000,000

3.2.8 Barriers, Risks and Mitigation Measures

Table 48: Barriers, Risks and Mitigation Measures

Challenge	Causes	Mitigating Actions	Responsibility
Unreliability and poor quality of electricity supply.	Inadequate generation capacity to meet the peak demand	Planning criterion to define the needed amount of power and the technology mix Use of Solar PV	GoK, KETRACO and KPLC
Timely electrification for universal access	Lack of implementation capacity and financial resources for minigrids	- Human capacity building - Provide low interest credit - Involvement of political leaders in project planning	Government (National and Sub-National)
The high costs of electricity supply in rural areas and the limited capacity of households to pay for the service make it difficult to attract investment in rural electrification.	Low population density scattered settlement and low power consumption	A system of tariffs and subsidies should ensure sustainable cost recovery while minimizing price distortions. Provision of micro-grids Use of alternative options such as Solar lantern and Solar Home Systems	Government / Private sector
CSOs Coordination structure between the National Government and County Government	Lack of proper coordination between regional countries on funding of regional projects	Setting up regional body to plan for regional infrastructures	National Government

3.3 Electrification of Agri-Based Facilities

Under Agri-based facilities, the plan has considered key agricultural activities to be carried out in the county to boost food security, generate income, employment, and economic growth of the county. Agricultural activities carried out in Kilifi County include crop farming, livestock keeping, and fishing in the Indian Ocean. The main crops grown in Kilifi County include cashew nuts, sisal, coconut, and cassava, as well as green grams, beans, maize, cowpeas, a variety of vegetables, sweet potatoes, mangoes, oranges, and watermelons. The livestock kept in Kilifi County include cattle, goats, sheep, and poultry, mainly chicken.

3.3.1 Electricity Access Status for Agro-Based Facilities

3.3.1.1 Water Supply for Crop Irrigation

- Sources of water for irrigation in Kilifi County include rivers, boreholes, and water pans/earth dams. The acreage under food crops and cash crops are 52,519.4 ha and 47,681 ha respectively. The acreage under food crops is higher than that of cash crops. The County's arable land is estimated to be approximately 6,891.2 k ha, with non-arable land of 5,407 k ha (Kilifi County Government, 2022). This indicates that 56 percent of the land is useful for agriculture, while 44 percent could be made useful through irrigation. This would help achieve and sustain SDG goal number one, which is to eradicate extreme poverty and hunger by 2030.
- Kilifi County is characterized by harsh climatic conditions in most hinterland areas and poor rainfall reliability. There is a high dependence on rain-fed agriculture, and due to poor rainfall reliability, farmers are losing crops and experiencing low harvests. The county is food insecure. Promoting irrigation-based agriculture along the rivers and water pans could reduce the impacts of unreliable rains and upgrade existing irrigation schemes. Over 94% of crop failures are attributed to drought (Kilifi County—SETA Team, March 2023).



- The National Government has invested in exploiting River Galana for irrigation under the Galana Kulalu mega food security project, including small-holder irrigation initiatives in Burangi and Mwangea.

National Government Projects in Kilifi

- Ensuring accessibility and availability of water by building dams can provide water for small- and large-scale irrigation.

Table 49: Planned Irrigation Schemes by National Government

Project	Location	Acreage in Ha	Type	Status	Facility	Agency
Burangi Irrigation Scheme	300 9'19"S, 400 04'50" Near Burangi Primary	1,200 ha	New	Proposed	Weir	CDA (Coast Development Agency)
Kavunyalalo Irrigation	-3.180298° 39.978986° Near Kavunyalalo Primary	8,240 ha	New	F/S	Weir	NIB (National Irrigation Board)
Sabaki Irrigation	-3.147196°, 40.122348° Near Sabaki Bridge	3,000 ha	Extension	F/S ongoing	Weir	NIB

Source: (Kilifi County Government, 2022)

The County government has continued previous national government initiatives of supporting the construction of minor irrigation water pans across the County. Currently, the water pans mainly supply water for livestock and domestic use. Several gravity-flow and pump-operated water pans have been completed, but little impact has been realized.

The County Government has identified and mapped out resources that have the potential for irrigated farming across its sub-counties, as indicated below:

i. Kilifi South Sub-County

The sub-county has seven water resources identified for irrigated farming, namely five earth dams, one farm with a water reservoir, and one water pan. All of them are communally owned apart from the farm water reservoir and the water pan that are privately owned, and the water pan has a water pumping infrastructure for irrigation connected to the power grid. The remaining six need a water pumping solution. The details of these water resources are given in Table 49.

Table 50: Electrification Status of Various Irrigation Schemes in Kilifi South

Parameter	Statistic			
Sub-counties	Kilifi South			
Wards	Junju	Chasimba	Mtepeni	Mwarakaya
Villages	Gongoni	Madzi Maruhe SLM, Ng'ombeni, Ziani	Matandale	Mwembekati, Pingilikani, Mwazang'ombe
Water sources	Earth dam, Borehole, Farm ponds	Water pan,	Water pan	Water pans, Boreholes, Farm ponds
Water Description	Existing/ proposed	Communal/ on farm	Grid /transformer proximity	Remarks (crops grown & Acreage)
Gongoni dam	Existing	Communal	>600	Horticulture (10 ha)
Farm ponds (water reservoir)	Existing	Private		Horticulture
Kasidi dam	Existing	Communal	> 600	Horticulture
Mtwana dam	Existing	Communal	Off-grid	Horticulture (8 ha)
Lutsangani dam	Existing	Communal	<600	Horticulture (8 ha)
Bendila dam	Existing	Communal	>600	
Ng'ombeni water pan	Existing	Private	Connected to the grid	Horticulture (14 ha) Maize, Nappier
The following parameters are not known. • Capacity of water sources (liters) • Daily water demand or supply (liters) • Feasibility studies will be carried out to establish the viability of installing water pumping systems for irrigation.				

ii. Magarini South Sub-County

The sub-county has five water resources identified for irrigated farming, namely the River Galana/Sabaki, three boreholes, and one water pan. All of them are communally owned, and three of them are under construction with two proposed. It should be noted that farmers carry out small-scale irrigation along the Galana/Sabaki River using diesel pumps. The remaining five need water pumping solutions. Kambicha, which is under expansion, has installed diesel water pump infrastructure for irrigation. The details of these water resources are given in Table 51.



Table 51: Electrification Status of Various Irrigation Schemes in Magarini

Sub-county	MAGARINI						
Ward	Gongoni, Magarini, Adu, Garashi						
Village	Sosoni, Mwangatini, Kambicha, Garashi						
Type	Borehole, water pan, earth dam, etc.						
Name	Existing/ proposed	Communal/ on farm	Grid / transformer proximity	Capacity (Litres)	Daily water demand or supply (Litres)	Average monthly power expenditure (KES)	Remarks (crops grown & Acreage)
Sosoni waterpan	Existing, being expanded	Communal	>600	105,000	-	N/A	Under construction by KCEP-CRAL Project for domestic and livestock use.
Mwangatini borehole	Existing (new)	Communal	Off-grid	7,500	Not yet operational	N/A	Under construction by KCEP-CRAL Project, for irrigation about 50 acres.
Kambicha borehole	Existing, being expanded	Communal	>600	300,000	56,000	150,000/=	Expanded by KCEP Project for domestic use, crops and trees growing about 20 acres & livestock use.
Garashi community borehole	Proposed	Communal	Off-grid	-	N/A	N/A	To be constructed by KCEP-CRAL Project soon. Hydrological survey done; public participation done.
N/B The Kilifi County Spatial Plan 2021–2030 identified the following areas in Magarini as having good potential for the development of irrigation schemes:							
Water resources	Galana/Sabaki river, arable land, potential for ecotourism, good terrain, well-drained soils, proximity to urban areas (markets), skilled labor, good physical infrastructure, aquaculture, flood potential, waterborne diseases, shortage of capital						
Sub-location	Baricho, Singwaya, Kakoneni, Gandini, Mkondoni, Longobaya, Masindeni						

Existing irrigation schemes along the River Sabaki and shallow wells

Sub-county	Magarini	Ward	Magarini, Adu, Garashi & Sabaki	
Village	Chakama, Masindeni, Mikuyuni,Bate, Burangi, Mwangatini, Sabaki		Water source	Sabaki River, shallow wells
Approximate no. of farmers			450	
Average daily water demand per farmer (liters)			Small: 4.73m³–6.6m³; Medium: 9.03m³–11.44m³; Large: 17m³–23.3m³	
Current source of pumping energy			Generators (petrol run), Solar energy, Gas being introduced by a few farmers	
Average cost of pumping energy per month			Small: 2,850–3,840/=, Medium: 5,760–7,680/=, Large: 11,520–15,360/= (For generator)	
Average acreage per farmer			Small 0.25 acres; Medium 0.5 acres; Large 1acre	
Types of crops grown			Assorted vegetables (tomatoes, kales, okra, brinjals, capsicum amaranthus); watermelon, maize, pawpaw, bananas	
No. of seasons per year			Two rounds especially during the dry periods for the vegetables.	

iii. Malindi Sub-County

The sub-county has 7 water resources identified for irrigated farming namely 2 water reservoirs, 4 boreholes and 1 water pans. Three of them communally owned while the remaining 4 are privately owned. One of the three communally owned is connected solar PV water pumping infrastructure while

the remaining 2 are not connected. Of the 5 privately owned, 1 is under construction and the remaining 4 are solar PV pumping systems installed. The details of these water resources are given in Table 52.

Table 52: Electrification Status of Various Irrigation Schemes in Malindi

Sub-county	Malindi						
Ward	Kakuyuni	Jilore		Malindi town, Ganda			
Village	Madunguni	Sobora, Bengoni, Slaloni		Furunzi and Kanyangwa, Mshongoleni			
Type	Borehole, water pan, earth dam.	Borehole, water pan, earth dam etc.		Water Reservoir			
Name	Existing/proposed	Communal/on farm	Grid / transformer proximity	Capacity (Litres)	Daily water demand or supply (Litres)	Average monthly power expenditure (KES)	Remarks (crops grown & Acreage)
Madunguni Miro-Irrigation scheme Borehole	Existing	Communal	Solar	60,000	200,000		Uses Solar
Kadimuni Water pan	Existing	Communal	>600	1,000,000	5,000	N/A	Growing Maize and Horticultural crops
Sosobora Kipepeo Waterpan	Existing	Communal	>600	-	5,000	N/A	Horticultural crops
2 Water reservoir	Under construction	Private	Off-grid	600,000 litres	3000 litres	N/A	Approximately 6acres of vegetables.
3 Boreholes	Existing	Private	Off-grid	N/A	3000 litres per farmer	Solar	12 acres of vegetables
22 water reservoirs	Existing	Private	Off-grid	300,000 litres each	30,000 litres		Used to grow horticultural crops
Kwa Bujra Borehole	Existing	Private	Solar	-	3,000	N/A	Horticultural crops
Bengoni Borehole	Existing	Private	Solar	-	3,500	N/A	Horticultural crops

Irrigation water supply from a river – farmers pumping water from rivers & irrigation canals

Sub-county	Malindi	Ward	Kakuyuni
Village		Madunguni, Paziani, Laini, M'mangani, Malimo and Mbogolo, Mongotini and Kisiwani Villages.	
Water source		Sabaki River, boreholes, water pans	
Approximate no. of farmers		800 Farmers	
Average daily water demand per farmer (litres)		40,000 litres	
Current source of pumping energy		Petrol, Solar and Diesel	
Average cost of pumping energy per month		KES 6,000	
Average acreage per farmer		1 Acre	
Types of crops grown		Tomatoes, okra, kales, watermelons, maize, mchicha, bananas, pumpkins, brinjales, cupscums, pawpaws	
No. of seasons per year		3 to 4 irrigation seasons annually.	



iv. Kaloleni

In Kaloleni, there are about 30 farmers were carrying out irrigation farming using river water. The farmers use a small diesel generator for pumping out water for irrigation. The details are indicated in Table 53.

Table 53: Electrification Status of Various Irrigation Schemes in Kaloleni

Sub-county	Kaloleni	Ward	Kaloleni	Village	Mwanzai
Water source	River				
Approximate no. of farmers	30				
Average daily water demand per farmer (liters)	-				
Current source of pumping energy	Small generators				
Average cost of pumping energy per month	10 liters per acre per week				
Average acreage per farmer	½ acre				
Types of crops grown	Vegetables				
No. of seasons per year	All year round				

3.3.1.2 Electrification Status of Crop Processing Facilities

Processing enhances market value, extends shelf life, provides opportunities for export to international markets, and development of industries, resulting in the creation of job opportunities and stimulation of economic growth. The Kilifi County Government is supporting the development of agro-processing facilities to boost its economic growth. Tables 54 to 55 show the status of various agro-processing facilities and their access to energy.

i. Kaloleni Sub-County

The sub-county has 3 crop processing facilities. 1 is communally owned, and the other 2 are privately owned. All of them are located in off-grid areas.

Table 54: Electrification Status of Various Crop Processing Facilities in Kaloleni Sub-County

Sub-county	Kaloleni						
Ward	Kaloleni						
Centre Name	Location	Existing/proposed	Communal/on farm	Grid / transformer proximity	Source of power	Average monthly cost of Power (main source + back up)	Waste generated per month—& disposal method
Kaloleni cooperative	Kaloleni town	Existing	Communal	Off-grid			N/A
Nyundo super foods	Kaloleni town		Private	Off-grid			N/A
Coco poa Ventures	Makoboani		Private	Off-grid			N/A

ii. Kilifi South Sub-County

The sub-county has 2 privately owned crop processing facilities. The facilities are connected to a 3-phase power supply and have a diesel generator for power backup.

Table 55: Electrification Status of Various Crop Processing Facilities in Kilifi South

Ward	Shimo la Tewa							
Centre Name	Location	Existing/proposed	Communal/on farm	Source of power	Power Quality	Back up Energy (e.g. grid, solar etc)	Electricity Phase	Waste generated per month—& disposal method
Biladi	Mtepeni	Yes	Private	Electricity	Good	Generator	3-phase	N/A
Jodari	Mtwapa	Yes	Private	Electricity	Good	Generator	3-phase	Installed disposable chambers

iii. Rabai Sub-County

The sub-county has 3 crop processing facilities: 1 privately owned, connected to the grid, and the other 2 communally owned. The communal owned facilities communal facilities fall within a 600 m radius from the transformer. One is connected to a solar PV electrical power supply system and uses firewood and charcoal for heating processes. The other communally owned facility is connected to a diesel generator for electrical power supply and uses firewood and charcoal for heat processing. The power generated by the diesel generator is not sufficient.

Table 56: Electrification Status of Various Crop Processing Facilities in Rabai Sub-County

Ward	Ruruma, Mwawesa, Rabai/Kisurutini							
Centre Name	Location	Communal/private firm	Existing/proposed	Source of power	Grid / transformer proximity	Power adequacy	Back up Energy (e.g. grid, solar etc)	Waste generated per month—& disposal method
Cocoponics Africa	Ruruma	Private	Existing	National grid	Connected	Adequate	Nil	No data
Mikahani farmers Association	Mikahani	Communal	None	Solar panel and Firewood/charcoal	<600 m	Adequate	Nil	No data
Mwangaza women group	Rabai	Communal	None	Diesel, Charcoal, Firewood	<600 m	Inadequate	Nil	No data



iv. Kilifi North Sub-County

The sub-county has 2 public owned crop processing facilities. The facilities are still under construction and are not yet connected to the national power grid.

Table 57: Electrification Status of Various Crop Processing Facilities in Kilifi North Sub-County

Ward	Matsangoni, Tezo					
Centre Name	Location	Communal/private firm	Existing/proposed	Source of power	Grid / transformer proximity	Waste generated per month—& disposal method
Matsangoni ware house New Maize milling Machine	Matsangoni	Public	Proposed	Electricity	<600m	Milling dust
Tezo Cassava Processing factory	Tezo	Public	On-going	Electricity	<600m	Peels, soil. Disposal soak pit

v. Malindi Sub-County

The sub-county has 1 privately owned crop processing facility. The facility is connected to a 3-phase power supply and has a solar PV power backup.

Table 58: Electrification Status of Various Crop Processing Facilities in Malindi Sub-County

Ward	Malindi								
Centre Name	Location	Communal/private firm	Existing/proposed	Source of power	Grid / transformer proximity	Power adequacy	Back up Energy (e.g grid, solar etc)	Average monthly cost of Power (main source + back up)	Waste generated per month—& disposal method
Coco pure	Malindi town	Private	Existing	Electricity	<600	Adequate	Solar	-	-

3.3.1.3 Electrification Status of Livestock and Fisheries Processing Facilities

1. Electrification of Milk Processing Centres

There are 10 milk collection cooling centres in the county. 6 are communally owned, 1 privately owned, and 2 public owned. The 2 milk collection centres in Ganze connected to the national grid are closed down. The Magarini Dairy Farmers Cooperative, which is communal owned, has a milk collection and cooling centre with a capacity of 1,500 litres per day and is connected to national grid power. It has a solar PV system but is undersized and therefore not able to run the cooling plant. The plant is experiencing financial challenges due to high electrical power bills. There are 2 privately owned milk cooling and cooling centres connected to the national electricity grid and they are operational. The remaining 5 communally owned are connected to the national electricity grid; one is operational and the rest are not operating.

Table 59: Electrification Status of Milk Processing Centres

Sub-county	Centre Name	Location	Source of power	Existing/proposed	Public/private/com-munal	Grid / transformer proximity	Power adequacy	Back up Energy (e.g. grid, solar etc)	Existing/proposed	Average monthly cost of Power (main +back up)	Remarks
									Projected load (Watts)		
Rabai	Rabai milk collection and cooling centre	Batani, Ruruma ward	Electricity	Existing	Com-munal	>600m	N/A	None			Not yet operating
Ganze	Bamba dairy	Bamba	Electricity	Existing	Com-munal			N/A			The collection centre closed: Rent, Drought.
Ganze	Ganze milk collection and cooling centre	Ganze	Electricity	Existing	Public	<600	Connected	N/A			Not in use. Fault/ rusty milk tank
Magarini	Magarini Dairy Farmer Cooperative Society	Gongoni before Gongoni Health Centre from the Gongoni stage	Electricity	Existing—500 litres/ day Proposed—1500 litres/ day	Public	<600	Connected	Solar	Switched completely to electricity	15,000	A cost-effective energy source is a requirement to sustain the production/ production.
Malindi	Malindi product limited	Ganda	Electricity	Existing—2000 litres	Private	<600	Connected	Grid		260,000	Cheese production
Chonyi	Amani Chonyi Dairy	Mwembe Kati.	Electricity	Existing.	Com-munal	>600 m	Connected	Electricity/ Solar		2000	Good Condition
Kilifi North	Zowerani	Tezo	Electricity		Private	<600m	Connected	—	600 W		Active
	Manyeso dairy	Watamu	Electricity		Com-munal	<600m		—	900 W		Dormant
	Umoja youth group	Kibarani		Existing	Com-munal	<600m		—	500 W		
	Ubora dairy	Tezo		Existing	Com-munal	<600m		—	600 W		



2. Electrification of Feed Processing Facilities

There are 12 feed milling and mixing facilities, out of which only 4 are connected to the grid. All the 12 facilities are communal apart from one which is public.

Table 60: Electrification Status of Feed Processing Facilities

Location	Source of power	Existing/ proposed	Public/ private/ communal	Grid / transformer proximity	Power adequacy	Back up Energy (e.g. grid, solar etc)	Existing/ proposed load (W)	Average monthly cost of Power (main +back up)	Remarks
Kasidi village (Ruruma ward)	Electricity	Existing	Communal	>600m	Not Connected	Diesel powered			It's new but not yet operating
Mwanzagu village (Rabai Kisurutini ward)		Existing	Communal	<600m	Not connected	None			New but not yet operating,
Chauringo (Kambe/Ribe ward)		Existing	Communal	<600m	Not connected	None	240V		New but not yet operating
Making (Kambe/Ribe ward)		Existing	Communal	<600m	Not connected	None	240V		New but not yet operating
Mbwaka (Kambe/Ribe ward)		Existing	Communal	<600m	Not connected	None	240V		New but not yet operating
Mbararani village		Existing	Communal	Off-grid			240V		New
Kasidi village (Ruruma ward)		Existing	Communal	>600m	Not Connected	Diesel powered			It's new but not yet operating
Gongoni Town next to PEFA Church	Electricity	Existing	Public	<600	Connected	Solar but not installed	200 watts	KES 6000	Incomplete. Need for a cost-effective energy source as either back or fulltime.
Kayafungo	Electricity	Existing	Communal	<600m	Connected	None	240	KES 1500	Functioning (needs bearing replacement)
Chasimba	Electricity	Existing	Communal	>600	Connected	N/A	240 watts	N/A	Still new
Mtwapa	Electricity	Existing	Communal	<600m	Connected	None	240 watts	3000/-	Good Condition
Matsangoni	Electricity	Existing	Communal			—	800 watts	6700 watts	

3. Electrification of Fishery Cold Storage Facilities

Fishing is one of the main economic activities of Kilifi County, Fish starts deteriorating immediately after it has been removed from water.

a) Electrification of Fishery Cold Storage Facilities in Kilifi North Sub-County

Table 61: Electrification Status of Fishery Cold Storage Facilities in Kilifi North Sub-County

S/ No.	Centre Name	Source of power	Existing/ proposed	Grid /trans-former proximity	Power adequacy	Back up Energy (e.g. grid, solar etc)	Remarks
Manarani Ward							
Communal owned							
1	Takaungu—existing cold store	Grid	Existing	N/A	Adequate	Diesel Genset	Inoperational due to high power bills
2	Takaungu—solar powered ice flake machine	Solar	Existing	N/A	Adequate	Grid	Constructed by WWF
3	Mnarani fish depot	Grid	Existing	N/A	Adequate		Main power consumption coming from freezers
4	Mnarani cold store and ice flake machine	Solar	Proposed	N/A		Grid	Solar powered cold store envisioned in County plans
Sokoni Ward							
Communal owned							
5	Kilifi Central fish depot	Grid	Existing	N/A	Adequate		
6	Kilifi Central cold store and ice flake machine	Solar	Proposed	N/A			Solar powered cold store envisioned in County plans
Tezo							
Communal owned							
7	Bofa Fish depot	Grid	Proposed	N/A			
8	Bofa cold store and ice flake machine	Solar	Proposed	N/A			Solar powered cold store envisioned in County plans
Matasangoni							
Communal owned							
9	Wesa fish depot	Grid	Proposed	N/A			
10	Wesa cold store and ice flake machine	Solar	Proposed	N/A			Solar powered cold store envisioned in County plans
11	roka fish depot	Grid	Proposed	N/A			Envisioned in County plans
12	Roka cold store and ice flake machine	Solar	Proposed	N/A			Solar powered cold store envisioned in County plans
13	Uyombo fish depot	Grid	Existing	N/A			
14	Uyombo cold store and ice flake machine	Solar	Existing	N/A		Diesel Genset	Solar powered cold store envisioned in County plans
Watamu							
Communal owned							
15	Watamu fish depot	Grid	Existing	N/A			
16	Watamu cold store and ice flake machine	Solar	Proposed	N/A			Solar powered cold store envisioned in County plans



b) Electrification of Fishery Cold Storage Facilities in Malindi Sub-County

Table 62: Electrification Status of Fishery Cold Storage Facilities in Malindi Sub-County

S/ No.	Centre Name	Source of power	Existing/proposed	Grid /transformer proximity	Remarks
Communal owned					
1	Mayungu fish depot	Grid	Existing	N/A	
2	Mayungu cold store and ice flake machine	Solar	Existing	N/A	Solar powered cold store envisioned in County plans
Shela					
Communal owned					
3	Shela Fish depot with cold store and ice flake machine	Grid	Existing	N/A	
4	Shela Ice flake machine	Grid	Existing	N/A	
5	Shela cold store	Grid	Existing	N/A	Inoperational due to high power bills

c) Electrification of Fishery Cold Storage Facilities in Magarini Sub-County

Table 63: Electrification Status of Fishery Cold Storage Facilities in Magarini Sub-County

S/ No.	Centre Name	Source of power	Existing/proposed	Grid /transformer proximity	Remarks
Ward					
Communal owned					
1	Kichwa cha Kati Fish depot with cold store and ice flake machine	Grid	Existing	N/A	
2	Ngomeni Fish depot with cold store and ice flake machine	Grid	Existing	N/A	
3	Gongoni fish depot	Grid	Proposed	N/A	Solar powered cold store envisioned in County plans
4	Gongoni cold store and ice flake machine	Solar	Proposed	N/A	Envisioned in County plans
5	Marereni cold store and ice flake machine	Solar	Proposed	N/A	Solar powered cold store envisioned in County plans
6	Marereni fish depot	Solar	Existing	5 km	Use of solar due to un-availability of grid power

d) Electrification of Fishery Cold Storage Facilities in Kilifi South Sub-County

Table 64: Electrification Status of Fishery Cold Storage Facilities in Kilifi South Sub-County

S/ No.	Centre Name	Source of power	Existing/ proposed	Grid / transformer proximity	Remarks
Shimo La Tewa Ward					
Communal owned					
1	Mtwapa fish depot	Grid	Existing	N/A	
2	Mtwapa cold store and ice flake machine		Existing	N/A	
Mtepeni Ward					
Communal owned					
3	Kanamai Fish depot	Grid	Proposed	N/A	
4	Kanamai cold store and ice flake machine	Grid	Proposed	N/A	Solar powered cold store envisioned in County plans
5	Kuruwitu fish depot — Kijangwani	Solar	Existing	N/A	
6	Kuruwitu office and storage —Kuruwitu	Solar	Existing	N/A	Solar installation not functional and the community/BMU is unable to replace it
7	Kuruwitu cold store and ice flake machine	Solar	Proposed	N/A	Solar powered cold store envisioned in County plans
Shimo La Tewa Ward					
Public					
8	Mtwapa ATC feed mill	Grid	Existing	N/A	Not yet operational
9	Mtwapa ATC lab—with raceways	Grid	Existing	N/A	Operational
10	Mtwapa ATC demo ponds (4)	Grid	Existing	N/A	Operational
11	Mtwapa ATC hatchery	Grid	Proposed	N/A	Envisioned in County plans
Privately owned					
12	Pwani Fish Farm Hatchery	Grid	Existing	N/A	Privately operated fish hatchery
13	Oshan fish Farm and Hatchery	Grid	Existing	N/A	Privately operated fish hatchery

3.3.2 Pathways for Electrification of Agro-Based Facilities

Water Supply for Irrigation

Kilifi County Government is putting in place measures that aims at increase the land under irrigation to booster boost food security and local employment. To improve productivity in low rainfall areas and enhance food security, three major irrigation schemes have been proposed. There are other small-scale irrigation projects at various riverine ecosystems, but these three should be given high priority. The projects are within the zone covered in rural development clusters 3 and 4. Small-scale irrigation should



also be encouraged in Magarini and Ganze, where the county should invest in drip irrigation systems and greenhouses. These efforts will improve food security, and they have to be implemented in harmony with the water sector strategy. This sector has to be implemented by both the Department of Water, Agriculture, and Cooperative Movement at both the National and County levels, with local farmers playing a key role.

Water irrigation is planned to increase significantly, and solar PV-powered pumps should be routinely considered as the energy source for these systems. Such technologies can help improve resilience to climate change. The County government will continue constructing pans and supply water pump engines for use by the irrigation target communities. Sustainability of the ongoing water pan minor irrigation initiatives will be addressed through adequate preparation of beneficiaries to manage these projects.

Introducing solar-powered pumps to replace fuel pumps for irrigation offers several compelling justifications. Solar-powered irrigation systems offer significant cost savings over fuel-powered pumps in the long term. While the initial investment for solar pumps may be higher, they have lower operating and maintenance costs since they rely on free solar energy. Farmers can save substantial amounts on fuel expenses, reducing their overall irrigation costs and improving their financial sustainability (World Bank 2018).

However, given the high capex cost, the county government would rather pursue a market-based approach. The market-based approach will aim to leverage market forces, private sector engagement, and consumer demand to facilitate the adoption of renewable energy solutions for agricultural irrigation. The project will involve collaboration between private sector stakeholders, financial institutions, technology providers, and local farmers to create a sustainable market ecosystem for solar-powered pumps. Through this market-based approach, the project aims to catalyze the growth of a vibrant market for solar-powered pumps in these regions, enabling farmers to access affordable, clean energy solutions for irrigation while promoting economic development, food security, and environmental sustainability in the area.

The project will be implemented by the county Department of Agriculture, supported by the county directorate of energy. The county government will play the following facilitative roles:

- Providing market assessment data on approximate market size. As it can be seen from the table 35 above, there is already a sizable market. Nevertheless, further market analysis is necessary to assess market dynamics, including pricing, distribution channels, and consumer preferences.
- The county government will further support the roll-out of targeted marketing campaigns, awareness-raising activities, and demonstration events to promote the benefits of solar-powered pumps and educate farmers about the advantages of renewable energy for irrigation. Farmer field days, technology showcases, and testimonials from early adopters will be used to showcase successful case studies and generate interest among potential buyers.
- The county government will also put in place robust monitoring and evaluation mechanisms to track the adoption, impact, and scalability of solar-powered pumps among the farming community. Key performance indicators, such as the number of installations, water savings, crop yields, and income generation, will be monitored to assess the effectiveness of the interventions and inform strategic decision-making.



With the above support in place, the private companies will be able to enter the market and establish distribution networks and sales channels to make solar-powered pumps accessible and available to farmers across the county. Partnerships with local retailers, agro-dealers, farmer cooperatives, and community-based organizations will be forged to facilitate product promotion, sales, and after-sales support services. The private companies will also be expected to innovate business models to ensure access and affordability. This goal will be achieved through the deployment of affordable financing instruments, such as loans, leasing, or pay-as-you-go (PAYG) financing, with a view to enabling farmers to invest in solar irrigation systems. Subsidies, grants, or incentives may be offered to early adopters or marginalized groups to reduce upfront costs and promote uptake among underserved communities.

Envisioned progression of Electrification of Agro-Based Facilities

Projects	Year					
	2023	2024	2025	2026	2027	2028
Number of Irrigation Water Pumping Schemes Electrified per year	0	0	6	7	7	7
Number of Crop Value Addition Facilities Electrified per year	0	1	1	2	1	0
Number of Milk Processing Facilities Electrified per year	0	0	1	1	1	0
Number of Feed Processing Facilities Electrified per year	0	1	3	5	5	4
Number of Fish Cold Storage Facilities Electrified per year	0	3	5	9	9	9

3.3.3 Estimated Investments for Electrification of Agro-Based Facilities

1. Electrification Cost of Irrigation Schemes Using Solar PV Systems.

As it can be seen from tables 65 to 69, either the farmers don't have electrical-powered water pumping systems, or they use diesel pumps for pumping the water to irrigate their farms. A private sector-led project is therefore proposed to introduce solar-powered pumps to the farmers irrigating along the rivers, especially River Galana/Sabaki.

Table 65: Capex Cost of Electrifying Irrigation Schemes Using Solar PV Systems in Kilifi County

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
Solar powered pumps	Suitable for irrigating up to 1 acre Flow rate: up to 10,000 litres/day Suction lift: 7m Total lift: 15m Warranty	70,000	1300	91,000,000.00
Total cost				91,000,000.00



2. Electrification Cost of Crop Value Addition Facilities

There are a total of eleven crop processing plants in Kilifi County. Three are communal, two public, and the remaining six private. Two privately owned plants are off-grid, while two are connected to 3-phase national grid power and have diesel generator backup. One private plant is connected to the grid but does not have a backup. The crop processing plants are connected to the national power grid. The two public crop value addition plants owned by the public are located within the grid but are outside the transformer radius of 600 m required for connectivity with no power backup. For the three communal crop processing facilities, one is off-grid and not connected, and two are within the 600 m radius of the transformer, but one is connected to a solar PV system and the other is connected to a diesel genset, which is expensive. The two communal facilities connected also use firewood and charcoal for industrial heating. The proposed project for the one off-grid communal facility is the installation of a solar PV powered system, and for those two that are on-grid, they should be connected to the 3-phase grid with a solar PV power system installed as a backup.

Table 66: Capex Cost Estimates for Electrification of Crop Value Addition Facilities in Kilifi County

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
1 off-grid communally owned	20 kW Solar PV system	50,000,000 referenced for GIZ Cost of 20 kW in 2015 was KES 50,000,000	1	50,000,000.00
2 on grid but 1 is powered by diesel generator and the other by Solar PV system to be connected to grid	3-phase	5,000,000	2	10,000,000.00
2 public to be connected to the grid	3-phase	5,000,000	2	10,000,000.00
Total cost				60,000,000.00

3. Electrification Cost of Milk Processing Facilities

Of the six communal milk cooling centres, only one connected to the grid with a solar PV power backup system is working; one is on-grid but outside the 600 metres radius from the transformer and is not connected, one is connected but closed down due to drought, and the remaining three communal facilities are dormant. The two private milk processors are connected to the grid and are not working. One of the private facilities has a solar PV power backup, and the other one has none. The remaining two milk processors are public-owned and connected to the grid; however, one of them closed down and the other is struggling with high electrical bills. The proposed project is the installation of a solar PV power system to supplement the grid power for the public-owned facility that is struggling with power bills and the private facility that has a backup and is functional. The other communal milk processors need to be investigated to find out their challenges.

Table 67: Capex Cost estimates for Electrification Interventions for milk processors

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
Grid connection	Three phase	500,000	1	500,000
Provision of solar PV infrastructure for supplementary power and also power back up	5000 litres	7,000,000	2	14,000,000
Total cost				14,500,000

4. Electrification Cost of Feed Processing Facilities

There are 12 feed milling and mixing facilities, out of which only 4 are connected to the grid. All 12 facilities are communal apart from one which is public. Three are in on-grid areas but outside the 600 metres radius of the transformer; four are in on-grid areas within a 600 metres radius, while one is in off-grid areas. Of the 4 that are connected, they don't have backup, and one is experiencing challenges in paying high power bills. The proposed projects are the installation of solar PV systems for the off-grid feed milling and mixing facility, and the connection of 4 within the 600 metres radius to the electrical power grid. Those connected to the power grid should be provided with a solar PV electrical system for backup and supplementary power.

Table 68: Capex Cost Estimates for Electrification of Feed Processing Facilities

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
Grid Connection those within 600 m radius from transformer	3-phase	500,000	4	2,000,000
Grid Connection those outside 600 m radius from transformer	Single phase	300,000	3	1,500,000
Install solar PV system to off-grid to solar PV system and solar back up to those connected to the grid	10 KW solar PV system	25,000,000	12	300,000,000
Total				303,500,000

5. Electrification Cost of Fishery Cold Storage Facilities Using Solar PV Systems

Fishing is one of the main economic activities in Kilifi County. Fish starts deteriorating immediately after being caught from the water. Kilifi County has 34 communally owned fish depots, out of which 19 are operational, while 15 have been proposed; there are also 2 privately owned hatcheries and 1 proposed public owned (Mtwapa Agriculture Training Center). Mtwapa ATC also has a feed mill for fish, 4 demonstration ponds, and a lab with raceways. The high number of proposed depots indicates the economic value attached to the fishing industry in Kilifi County. Electricity bills are a major cost that affects the profitability of fish businesses; two of the depots are not operating due to inability to pay outstanding electrical bills. There is one fish depot, the Kuruwitu office and storage, that has an installed solar PV system that is not working. All the proposed 15 depots will be powered by solar PV electrical power. The proposed project includes repairing the solar PV system at Kuruwitu office and storage, installing solar PV systems to power the proposed 15 depots, in addition to the 2 that are not operational due to the inability to pay electrical bills, and solarizing the existing 18 depots so that the solar PV replaces or supplements grid power.

Table 69: Capex Cost Estimates for Electrification of Fish Cold Storage Facilities Using Solar PV Systems

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
Electrify all the existing 19 and the 15 proposed cold storage with 10 KW solar PV system,	10 kW solar PV system	25,000,000	34	850,000,000
Repair of the Solar PV system at Kuruwitu office and storage	Repair and upgrading of the solar PV system	20,000,000	1	20,000,000
Total cost				870,000,000



3.3.4 Barriers, risks and mitigation measures

Challenge	Causes	Mitigating Actions	Responsibility
Unreliability and poor quality of electricity supply	Inadequate generation capacity to meet the peak demand	Planning criterion to define the needed amount of power and the technology mix Use of Solar PV	GoK, KETRACO and KPLC
Timely electrification for universal access	Lack of implementation capacity and financial resources for minigrids	• Human capacity building • Provide low interest credit • Involvement of political leaders in project planning	Government
The high costs of electricity supply in rural areas and the limited capacity of households to pay for the service make it difficult to attract investment in rural electrification	Low population density scattered settlement and low power consumption	A system of tariffs and subsidies should ensure sustainable cost recovery while minimizing price distortions. Provision of micro-grids Use of alternative options such as Solar lantern and Solar Home Systems	Government Private sector
CSOs Coordination structure between the National Government and County Government	Lack of proper coordination between regional countries on funding of regional projects	Setting up regional body to plan for regional infrastructures	National Government

3.4 Access to Clean Cooking Services

3.4.1 Introduction

Access to clean cooking services means access to (and primary use of) modern fuels and technologies, including natural gas, LPG, electricity, bioethanol, and biogas, or improved biomass cookstoves that deliver significant improvements compared with basic biomass cookstoves and three-stone cookstoves. Improvements in pollutant levels from improved biomass cookstoves were often overstated, with virtually no biomass cookstoves on the market meeting WHO standards for exposure to household air pollution. In line with SDG number 7 (SDG 7), Kenya has an ambitious target of achieving universal access to modern cooking solutions by 2030. These solutions include LPG, electricity, biogas, bioethanol, and improved solid fuel cookstoves.

About one in every two (49%) households use only one type of stove, while 36% use two types of stoves. The remaining 15% have three or more options. Eighty percent of the estimated 6.2 million households that use only one cooking option rely solely on either charcoal or fuelwood. Over the years, energy researchers have observed that when new cooking solutions are introduced in a household, existing options are rarely displaced. Rather, it is more common to see new options incorporated into cooking practices in combination with existing technologies. This may involve using multiple technologies to prepare a single meal, using different devices to prepare different meals throughout the day, or other variations. Stacking is widespread among Kenyan households, with 51% of households using more than one cooking device and one-sixth using three or more devices (G.o.K, Ministry of Energy and Petroleum, 2019).

Kenya's ratification of the Paris Agreement was domesticated into the law of Kenya according to Article 2, Section 6 of the Constitution of Kenya 2010. Under the Nationally Determined Contribution, Kenya seeks "to abate GHG emissions by 32% by 2030 relative to the business-as-usual scenario of 143 CO₂eq." According to the draft NCCAP for 2018–2022, the largest proportion of these reductions is expected from shifts in energy demand. The adoption of alternative fuels, including LPG and ethanol in urban areas and improved biomass cookstoves in rural areas, is estimated to contribute to 7.3 MtCO₂eq in reductions. Additionally, this shift is expected to have significant health benefits, including "reducing deaths from household air pollution from 49% of the annual total deaths (21,560 in 2017) to 20%."

3.4.2 Policies and Regulations that Relate To Clean Cooking

1. **The Energy Act of 2019** provides some clarity on what these responsibilities entail. Relevant to this cooking sector study is the county governments' responsibility in regulating and licensing:
 - i) biomass production, transport, and distribution;
 - ii) biogas systems; and
 - iii) charcoal production, transportation, and distribution.
2. **Charcoal Regulations (2009)**
3. **Forest Act (2009)** The Forest (Charcoal) Rules of 2009, revised in 2012 by the Energy Regulatory Commission (ERC—now EPRA), act upon some of the articles of the Energy Act of 2006, specifically those regulating the sustainable production, transportation, and marketing of charcoal.

The Forest Conservation and Management Act of 2016 retains the licensing role of KFS, noting that the service is to “receive and consider applications for licenses or permits in relation to forest resources” and to “implement and enforce rules and regulations governing importation, exportation, and trade in forest produce.” Among the regulations provided for by the Act are those concerning the production, transportation, and marketing of charcoal.
4. **The Energy (Liquefied Petroleum Gas) Regulations of 2009** are subsidiary regulations anchored in the Energy Act of 2006. These regulations outline the licensing requirements for those involved in the LPG business, including the importation, bulk storage, filling, transportation, wholesale, and retail trade of LPG.
5. **The Energy (Improved Biomass Cookstoves) Regulations of 2013** are intended for manufacturers, importers, distributors, technicians, and contractors of improved biomass cookstoves, as well as institutions using biomass fuels for cooking and heating purposes. Institutions that rely on biomass for cooking are required to install improved biomass cookstoves and maintain records of the stoves installed on their premises. The regulations also set out various classes and requirements for licensing for installation, maintenance, manufacture, importation, and distribution of cookstoves for both household and institutional use.
6. National Standards KEBS has developed specific standards for improved cookstoves. Among these standards are: KS 1814–2018 Biomass Stoves—Performance Requirements and KS 2759–2018 Ethanol-Fueled Cooking Appliances—Specifications, which are highlighted below; KS 2520–2014 Domestic Biogas Stoves—Specification; ISO 17225-3:2014 Solid Biofuels—Fuel Specifications and Classes Part 3: Graded Wood Briquettes; and ISO 17225-7:2014 Solid Biofuels—Fuel Specifications and Classes Part 7: Graded Nonwoody Briquettes, among others.
7. Petroleum Regulations
 - a) The Petroleum (Amendment—No 2) Rules, 2003 - LN 197
 - b) The Petroleum (Amendment) Rules, 2002 - LN 31
 - c) The Petroleum (Amendment) Rules, 2000 - LN 64
 - d) The Energy (LPG) Regulations, 2009
 - e) The Energy (Strategic Stock) Regulations, 2008
 - f) LPG Policy 2015 (Draft)



3.4.3 Key Stakeholders in Access to Clean Cooking

Clean Cooking Association of Kenya (CCAK)

The CCAK is a not-for-profit, business membership organization with members from both the private sector, development organizations, and individuals with an interest in the clean cooking agenda. It is technology agnostic and represents the interests of members and stakeholders engaged in providing cleaner and more efficient cooking solutions in Kenya. CCAK is the sector champion advocating for an enabling policy and market environment and developing the capacity of its members and other stakeholders to contribute actively to the universal adoption of clean and efficient cooking solutions in Kenya. The association works with both national and county governments, the private sector, and development partners to foster the growth of the clean cooking sector. Since its formation in 2012, CCAK has championed and advocated for the adoption of clean cooking solutions in addition to lobbying for a favorable enabling environment for the clean cooking sector.

3.4.4 Past and Current Initiatives on Access to Clean Cooking Solutions

1. Energy 4 Impact/Mercy Corps Initiatives

- a) There is the Green Climate Fund (GCF) project, which is funded by GIZ and implemented by Mercy Corps. The project aims to promote ‘Climate Friendly Cooking in the Coastal Region of Kenya’ to accelerate Improved Cookstoves (ICS) sector growth in the coastal region by unlocking the potential of last-mile distribution channels for ICS through market development support and consumer education.
 - b) **Kenya’s Energy and Cash Plus Pilot Project:** This 20-month pilot tested new approaches for linking cash transfer beneficiaries in two of the most deprived areas (Kilifi and Garissa) in Kenya with off-grid energy solutions. Designed to integrate into the country’s social protection programme, the Energy and Cash Plus pilot project supports the government’s ambition to achieve universal energy access by 2022 for the most vulnerable segment of the population. Funded and managed by UNICEF, Energy 4 Impact is working with the Busara Centre for Behavioural Economics and Somali Aid to support the implementation of the programme.
 - c) **Scaling-Up Wire (Nishati Na Wanawake):** This programme sought to build on the success of the multi-year Women in Renewable Energy (WIRE) programme and expand its reach to six additional energy-poor rural counties in Kenya and Tanzania. With improved cookstoves at its heart, the expansion, funded by The Adventure Project, will help more women-led enterprises further develop the market for clean cooking while also minimizing carbon dioxide emissions and creating more jobs.
- #### 2. Kenya Off-Grid Solar Access Project (KOSAP)—2017 to 2023:
- The project supports clean cooking companies to enter and penetrate the clean cooking market in the county. The KOSAP, a flagship project of the Ministry of Energy running from 2017 to 2023 and financed by the World Bank, seeks to “increase access to modern energy services in underserved counties of Kenya.” According to the Project Appraisal Document, Subcomponent 2B of the project, with an allocation of US\$6 million, concerns clean cooking solutions for households. The project will promote “cleaner household cooking appliances and fuels” in efforts to help target counties (including West Pokot, Turkana, Isiolo, Samburu, Marsabit, Kilifi, Kwale, and Taita Taveta) transition to cleaner, more efficient improved stoves. Stoves promoted under the project include woodstoves that are at least Tier 2 (roughly 30 percent efficient) and Tier 3 charcoal stoves (roughly 40 percent efficient).



3. **The Gas Yetu**—The Mwanachi Gas Project by NOCK aims to distribute 6 kg complete LPG cylinders with the goal of increasing LPG penetration to 70% by 2020. The project design includes the distribution of complete LPG cylinders at a discounted price of KES 2,000, enabled by a government subsidy on the initial cylinder stove, and development of last-mile distribution channels where the distribution model involves working with at least one distributor per sub-county.
4. **World Wide Fund for Nature Kenya (WWF)** has been working in Kenya since 1962 alongside the government, civil society, private sector organizations, and local communities by contributing towards providing an enabling environment for the achievement of sustainable natural resource management. Kenya's natural resources are diminishing at a fast rate, while the human footprint is increasing. WWF's focus areas are integrated freshwater resource management, management of marine resources, conservation and restoration of disappearing forests, supporting equitable sharing of natural resources, tackling climate change, and promoting clean energy initiatives by encouraging the use of renewable energy. Additionally, they redirect financial flows to support conservation and sustainable ecosystem management and influence environmental policies at county and national levels by engaging jointly to develop effective public policy on wildlife conservation, protecting Kenya's most ecologically important places and wildlife species. WWF is working with CCAK on a project dubbed "Enabling Environment for Clean Cooking Adoption for Reduced Climate Impact at the National Level and at the county level with Kilifi County."
5. **The County Government of Kilifi is promoting the development of biogas technology in the county through:**
 - a) GIS mapping of biogas resources;
 - b) Introduction of biogas training in technical and vocational training;
 - c) Training of energy staff at the Department of Energy;
 - d) Developing plans for the installation of biogas plants;
 - e) Carrying out pilot projects of household and institutional biogas systems.

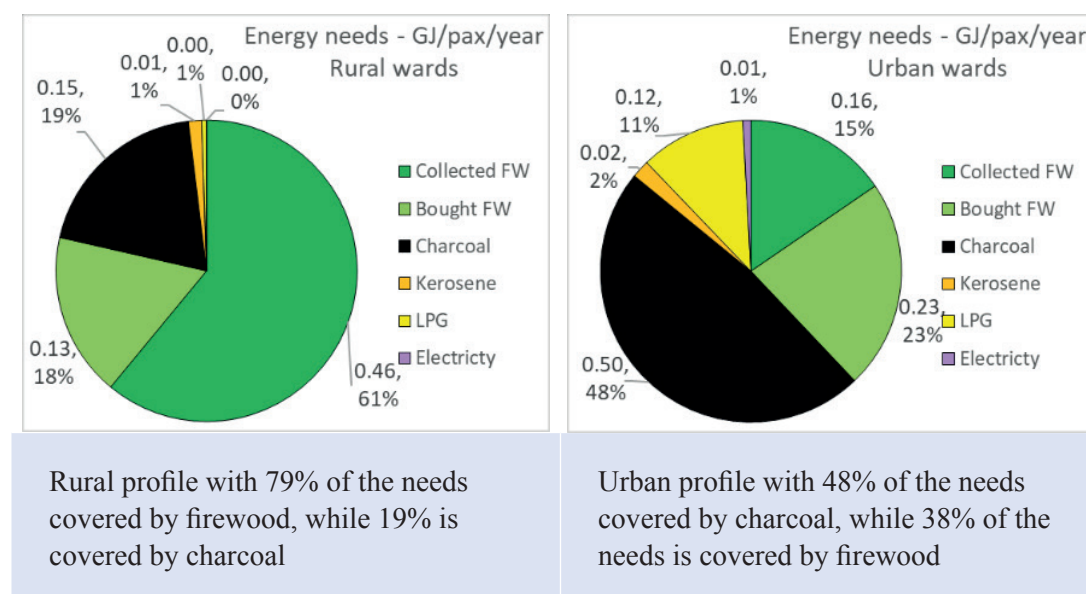
3.4.5 Energy Cooking Situation At Households

Cooking solutions refer to any combination of technology/appliance (cookstoves) and fuel used for cooking. Cooking technologies are classified into traditional and improved cooking solutions. Traditional cooking solutions refer to baseline cooking technologies that employ no functional considerations for fuel and/or thermal efficiency. Examples include the three-stone fire, open U-shaped clay or mud stoves, metal charcoal stoves, and unvented coal stoves. Improved cooking solutions refer to cooking solutions that improve, however minimally, the adverse health, environmental, or economic outcomes from cooking with traditional solid fuel technologies. This definition encompasses clean cooking solutions and the entire range of improved biomass cookstoves.

65% of Households (HHs) in Kilifi consider firewood as their primary fuel, with 47% of the HHs relying solely on firewood with no secondary fuel. Charcoal is the primary fuel for 30% of the HHs and the main secondary fuel in Kilifi, especially for urban HHs, where it is used by 77% of the HHs, followed by LPG, which is used by 18% of the urban HHs. The adoption of charcoal ICS is good (80% adoption rate for the urban HHs), but firewood ICS are practically non-existent in the Kilifi cooking landscape. Figure 31 shows a summary of cooking Energy consumption in Kilifi County households by type.



Figure 32: Summary of Cooking Energy Consumption in Kilifi Households by Fuel Type

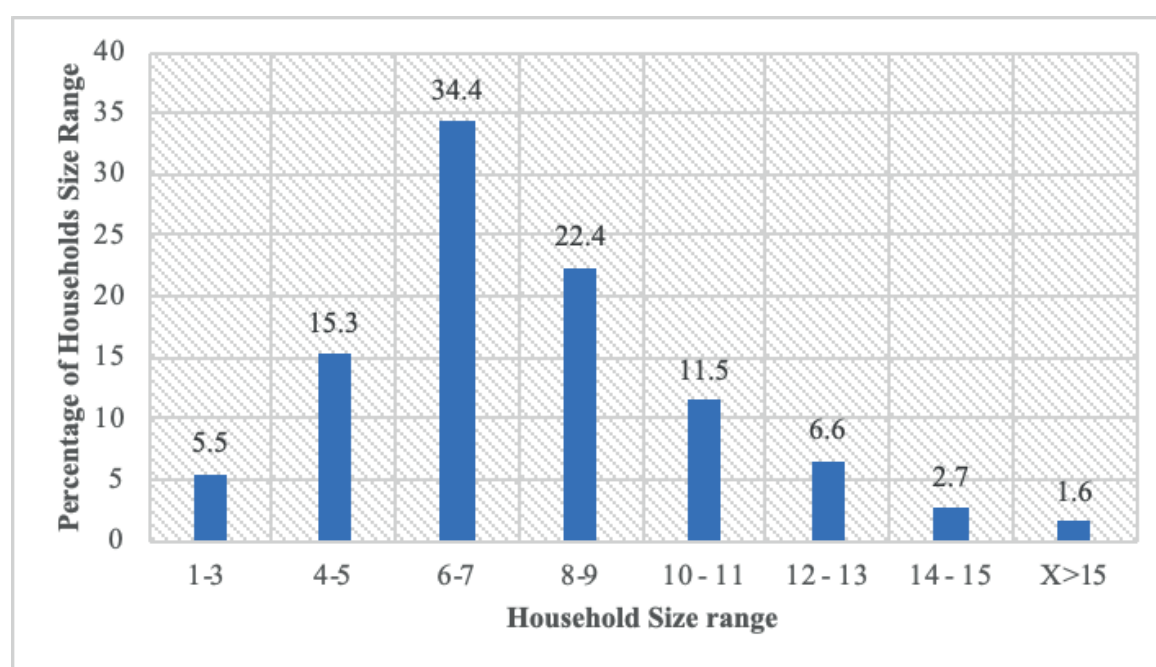


Source: (Kilifi County—SETA Team, March 2023)

3.4.5.1 Cooking Situation and Demography

From the data analysis, 20.8% of the households have 5 members and below, 56.8% of household size consists of members from 6 to 9, while 22.4% of the households have more than 10 members and above. The average household size is 5.7.

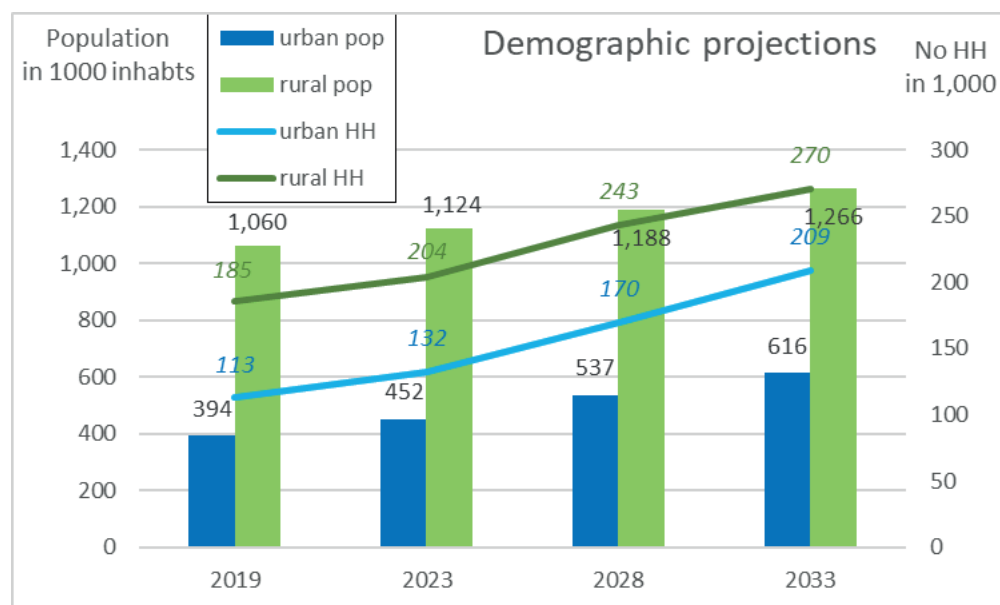
Figure 33: Size of Households



Source: (Kilifi County—SETA Team, March 2023)

The cooking situation is likely to evolve with the transformation of Kilifi County due to urbanization. In 2019, the urban population at 397,000 represented 27% of the total population with urban HHs at 113,000 representing 37% of the total HHs as shown in Figure 38. This is expected to change in the next 10 years, with urbanization increasing from 27% to 33% at an annual growth rate of 3.5%. The urban HHs are expected to increase by 77,000 to 209,000 and account for 45% of total HH by 2033.

Figure 34: Demographic Projection for Kilifi



Source: (Kilifi County—SETA Team, March 2023)

3.4.5.2 Analysis of Kilifi Cooking Solutions

3.4.5.2.1 Stoves

Figure 35: Wood Stoves



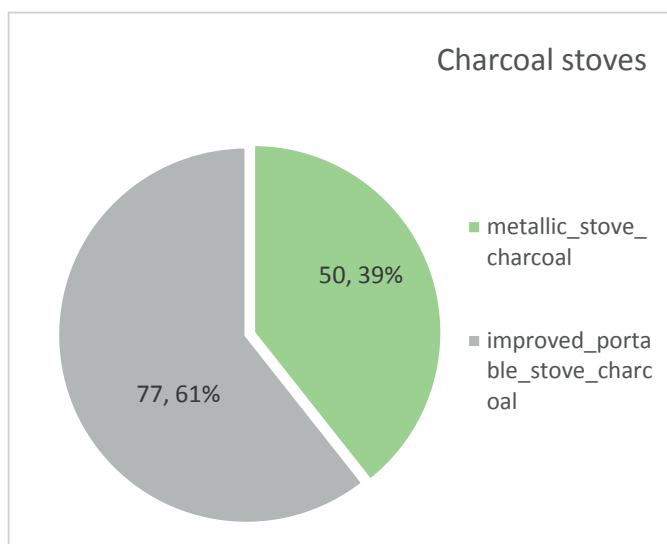
97.1% of households use woodstoves:

- 95% use traditional TSOF stoves with very low efficiency
- 4% use a portable ICS (28% efficiency)
- 1% use masonry stoves (25% efficiency)

In rural areas, all firewood stoves are TSOF types.

Source: (Kilifi County—SETA Team, March 2023)

Figure 36: Charcoal Stoves



79% of households use a charcoal stove:

- 39% use metallic charcoal stoves with poor efficiency (20%)
- 61% use improved portable charcoal stoves (30% efficiency)

In rural areas, the proportion is 44% for standard stoves and 66% for improved stoves.

Source: (Kilifi County—SETA Team, March 2023)

For LPG, 10% of households have a burner on a cylinder (meko type), and 90% have a gas stove. The efficiency of the meko burner is lower (60%) than the more wind-protected burners installed in a gas stove (65%). There is only one gas stove in rural areas.

3.4.5.2.2 Purchase of Cooking Fuels and Preliminary Estimates of Bought Quantities.

To convert purchases into quantities, assumptions were retrieved from the Kenya household cooking sector study (2019).

Table 70: Price of Cooking Fuels

	Price	Calorific value
Wood	10 KES/kg	15 MJ/kg
Charcoal	40 KES/kg	28 MJ/kg
Kerosene	150 KES/l	43 MJ/l
Electricity	28 KES/kWh	3.6 MJ/kWh

3.4.5.2.2.1 Purchase of Firewood

45 households buy firewood, corresponding to an average of 130 kg per household/month or 20.9 kg per person/month (0.7 kg wood per person/day).

Table 71: Firewood Bought by Households

	Quantity kg/month/HH	kg/per person/month	kg wood/person/day
Average of 45 HH	169	27.2	0.91
Average of 17 urban HH	159	25.3	0.84
Average of 21 rural HH	173	28.7	0.96
Average of 7 peri-urban HH	177	27.7	0.92

Source: (Kilifi County—SETA Team, March 2023)

It's quite interesting to note the convergence of the three quantities around the average of 0.91 kg wood per person/day, independently of the household origin.

3.4.5.2.2.2 Purchase of Charcoal

98 households buy charcoal, averaging 34 kg per household/month, or 6.0 kg per person/month (0.2 kg charcoal per person/day).

Table 72: Charcoal Bought by Households

	Quantity kg/month/HH	kg/per person/month	kg wood/person/day
Average of 98 HH	34	6.0	0.20
Average of 57 urban HH	31	5.6	0.19
Average of 31 rural HH	42	7.5	0.25
Average of 10 peri-urban HH	21	3.6	0.12

Source: (Kilifi County—SETA Team, March 2023)

The convergence of urban, peri-urban, and rural data is not as prominent for charcoal as it is for wood. However, urban and rural consumption averages are comparable.

3.4.5.2.2.3 Purchase of LPG

27 households use LPG, with an average of 5.2 kg LPG per household/month, or 0.9 kg LPG per person/month (0.03 kg LPG per person/day).

Table 73: LPG Bought By Households

	Quantity kg/month/HH	kg/per person/month	kg wood/person/day
Average of 27 HH	5.2	0.9	0.03
Average of 23 urban HH	5.4	1.0	0.03
Average of 2 rural HH	4.5	0.4	0.015
Average of 2 peri-urban HH	3.8	0.8	0.03

Source: (Kilifi County—SETA Team, March 2023)



The average quantities bought by urban and peri-urban households are quite similar, potentially showing similar behavior. The two rural households host 23 people, and LPG use is likely limited to specific tasks like heating water for tea.

3.4.5.2.2.4 Purchase of Kerosene

15 households use kerosene for cooking purposes, buying an average of 4.2 liters per month, equating to 0.8 liters per person/month (2.6 deciliters per person/day).

Table 74: Kerosene Bought by Households

	Quantity l/month/HH	l/per person/month	l kerosene/person/day
Average of 15 HH	4.2	0.8	0.026
Average of 7 urban HH	4.6	0.9	0.030
Average of 21 rural HH	4.4	0.7	0.023
Average of 2 peri-urban HH	2.3	0.6	0.019

Source: (Kilifi County—SETA Team, March 2023)

A good convergence in kerosene consumption per person per day is noted for urban and rural households. For peri-urban households, limited purchasing power seems to restrict the buying of kerosene and charcoal.

3.4.5.2.3 Computation of Cooking Energy Needs for the Three Categories of Household

1. General Principles

The previous analysis looked at different types of fuels and technologies for each category of households. Since cooking is a multi-fuel and multi-technology activity, we need to assess the energy needs of each household as they use various fuels and technologies (e.g., LPG for tea, Three-Stone Open Fire (TSOF) for ugali, charcoal for wet meat preparation). The aim is to compute how much energy is required for cooking across all these methods, ensuring that each person receives enough calories for a healthy, active lifestyle. And this number of calories is more or less constant depending on the level of physical activity.

2. Calculating Energy Needs

For each household, we associate each element of energy consumption with its useful energy value, i.e., the energy required to turn raw materials into edible food. Example: Using 3 kg of firewood on a TSOF to cook a meal consumes $3 \text{ kg} \times 15 \text{ MJ} = 45 \text{ MJ}$ of primary energy, but only 6.75 MJ of useful energy is available due to the TSOF's low 15% efficiency. Cooking the same meal on an efficient rocket stove (30% efficiency) would require half the firewood, i.e., 1.5 kg. The exercise is to compute each household's and each person's energy needs in GJ per household per year and GJ per person per year.

3. Example to Unpack the Methodology

Consider one urban household in Mariakani Ward, Majengo settlement, with 5 people and a monthly income of 5,000–10,000 KES.

Table 75: Energy Needed Per Person Per Year

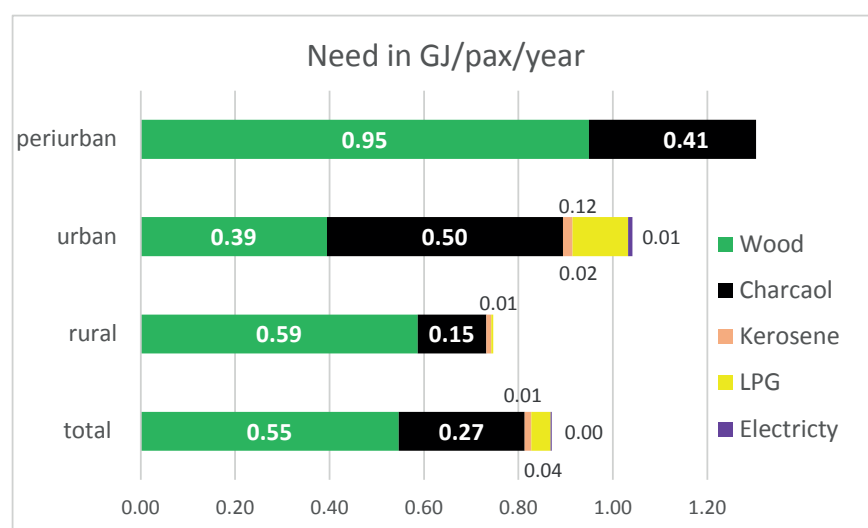
		KES/month	kg/month	kg/year	Average efficiency	GJ/hh/y	Need GJ/person/y
Primary Fuel	Charcoal	2000	50	600	28%	4.62	0.92
Secondary Fuel	LPG	1300	6	72	65%	2.15	0.43
Tertiary Fuel	Firewood	300	30+4.3 (collected)	412	15%	0.93	0.19
						7.70	1.54

Source: (Kilifi County—SETA Team, March 2023)

The household has one TSOF, one metallic, and one ICS charcoal stove (average efficiency 20/35% = 27.5%) and one gas stove.

The calculation was done for each of the 184 records, and the consolidated result was disappointing, with low average energy needs per person/year ranging from 0.71 to 1.30 GJ/person/year (compared to standard values of 1.2 to 2.5).

Figure 37: Energy Need in GJ/Person/Year

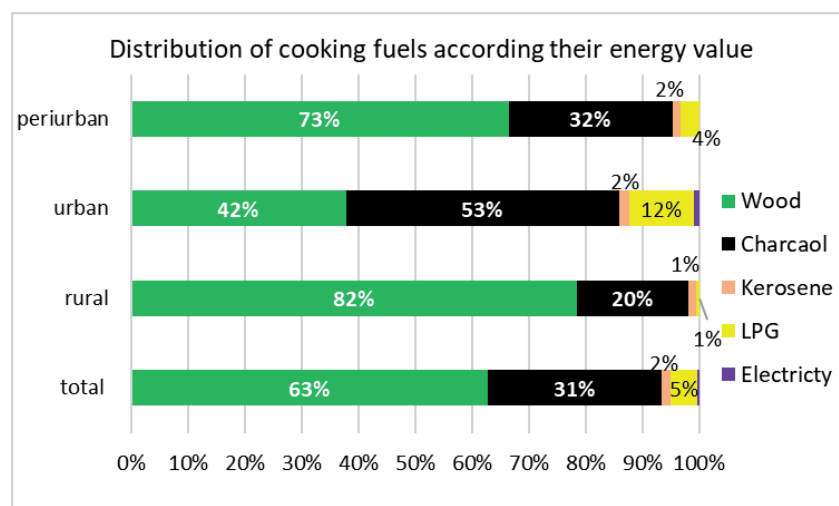


Source: (Kilifi County—SETA Team, March 2023)

The figure also shows the proportion of each fuel used for cooking. Charcoal represents a significant share—more than 30% at the county level and over 50% in urban areas.



Figure 38: Distribution of Cooking Fuels According to Their Energy Value



Source: (Kilifi County—SETA Team, March 2023)

Based on this data and the average efficiency of wood, charcoal, and LPG (15.39%, 27.76%, and 60.77%, respectively), it is possible to calculate the actual demand for each cooking fuel.

3.4.5.2.4 Barriers to Adoption and Use of Improved Clean Cooking Technologies at Households

1. Policy and Regulatory Barriers

Creating an enabling environment for the production and importation of ICS is key in ensuring that the products are available in the market at an affordable cost. Some policies, such as waivers of import duty for the raw materials used for the manufacture of cookstoves, have promoted the development of the clean cooking sector. However, some have negatively affected different players on the supply side of cookstoves and fuel, as discussed below. For example, the imposition of a 35% import duty on non-electric cooking appliances has affected ethanol fuel importers who must import both the cookstoves and fuels, as they are not produced locally. This is in addition to the import duty and VAT on the fuel. This cost is passed on to the end-users, who may find the stove and fuel unaffordable, thus hindering market penetration.

The import of raw materials for the manufacture or assembling of cookstoves is zero-rated. This is a right step in promoting local manufacturing but a disadvantage to the importers who share the same market with local manufacturers/assemblers.

To streamline the national policies, the County Government of Kilifi will need to provide fiscal incentives, as well as increased budget allocations to promote clean cooking as required. The county should also establish clear policy goals to guide universal access to clean cooking. Budget allocation can be used to provide smart subsidies to ensure consumers can afford the products, thereby reducing price points across the clean cooking value chain.

In August 2016, the Banking (Amendment) Bill 2015, which set a cap on the lending rate at no more than 4% above the Central Bank base rate, was signed into law. The amendment came into effect a month later.

Banks in Kenya eventually scaled down on providing loans and micro-loans, choosing to direct most of their lending to government debt instruments. This has negatively affected access to finance among sector players.

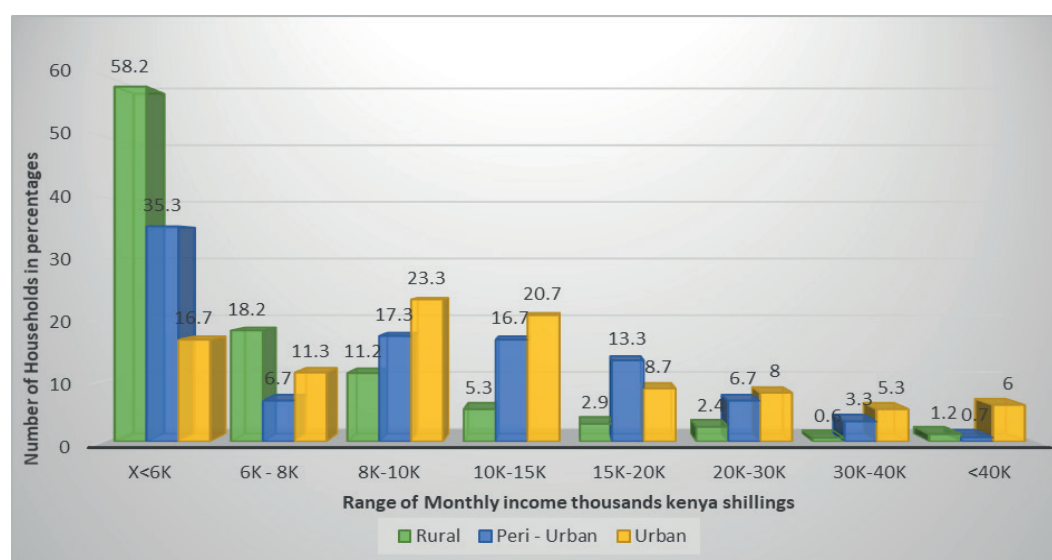
Another challenge in the policy environment is the lack of inclusion of the views of key stakeholders in the sector. One example is the formulation of the KEBS biomass performance requirement standard. The standard has requirements for safety, durability, emissions, marking, packaging, storage, and usage that manufacturers/importers must adhere to. From the discussion, the standards are so high that it makes it impossible to produce or sell biomass cookstoves in Kenya, as no manufacturer can meet the stipulated requirements. Although the leading manufacturers were consulted, their views were not included in the final document.

2. Finance Barriers

From the supply side, production, testing, creation of consumer awareness, and last-mile distribution activities of cookstoves within the supply chain remain capital-intensive. This is one reason why there is only one energy center: Mtwapa Energy Centre, situated in Kilifi County, serving five counties, namely Kilifi, Mombasa, Kwale, Taita Taveta, and Lamu. The Centre is government-owned under the Ministry of Energy. It offers capacity building in the production of ceramic cookstoves and produces two types: the Kenya Ceramic Jiko (KCJ)—charcoal cookstove and the Maendeleo-firewood cookstove. The center is underfunded, hence it does not play its role effectively.

From the demand side, the barrier is structured in two forms: the initial cost of acquiring the ICS and the subsequent cost of the fuel. The initial cost of acquiring an ICS is higher compared to traditional cooking technologies. For example, a three-stone stove has no initial cost. But if this end-user wanted to obtain an improved branded biomass stove, they would need between KES 2,800–5,200 (USD 28–52). This is contrasted with the KCJ, which retails between KES 300–700 (USD 3–7), and the kerosene wick stove, which retails between KES 300–1,500 (USD 3–15).

Figure 39: Households' Monthly Income in Kilifi County



Source: (GROOTS Kenya, September 2019)

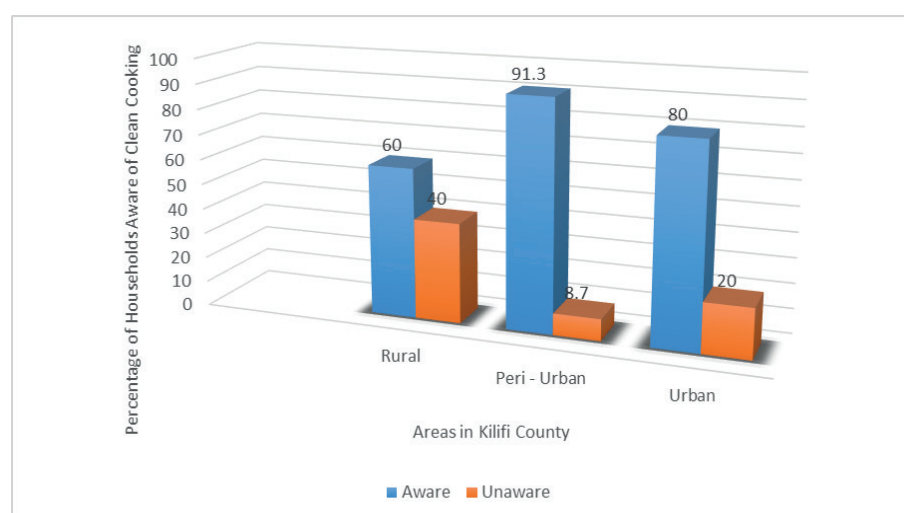
The cost of fuel can be a barrier if it is being introduced for the first time (for example, an end-user who has been collecting firewood for free) or if the fuel is only available in large quantities that require lump-sum payments. The cost of refueling a 6 kg complete LPG cylinder is KES 900 (USD 9) and lasts for 4 weeks for the average household of 4 members using it as a primary fuel. This survey estimates that the average cost of 1 kg of gas for urban households is KES 155 (USD 1.55), while for rural households, it stands at KES 160 (USD 1.6), lasting approximately one week depending on the rate of use. The average cost of one liter of kerosene is KES 100 (USD 1) for both rural and urban areas. From the analysis of data collected from the field, 58.2%, 35.3%, and 16.7% (Figure 6) of households in rural, peri-urban, and urban areas in Kilifi County live below the poverty line of USD 1.90 per day in 2011 PPP. This partly explains why the percentage of households using three-stone stoves is 87.7% in rural areas, compared to 67.3% and 19.3% in peri-urban and urban areas, respectively (GROOTS Kenya, September 2019).

3. Market Intelligence and Awareness

Manufacturers, importers, and distributors of various cooking technologies and fuels lack access to information from the rural and remote areas that need their solutions most. Only a few have the resources to carry out the needed market assessment to improve their service offerings. In this study, for example, we find changing the payment plan from upfront cash to a 6-month payment plan increases the willingness to pay for a 6 kg complete cylinder.

On the demand side, knowledge and awareness of existing cooking technologies in the market and the effects of traditional cooking technologies are key in determining the kind of technology that a household will purchase. People are not aware of some of the new cooking technologies in the market. From the clean cooking context analysis fieldwork survey, the percentage of households' responses to awareness of clean cooking solutions is shown in Figure 18. From the figure, the level of awareness of improved cookstoves is quite high at 83.8%. This means the high level of three-stone cookstove use at 87.7% is not necessarily due to a lack of awareness.

Figure 40: Percentage of Households Aware of Clean Cooking



Source: (GROOTS Kenya, September 2019)

4. Technological Barriers

Some ICS are limiting in terms of their design, particularly regarding stability and the diameter of the cooking space. In this study, diameters ranged between 24–29 cm. This makes it hard to use for very large families who require large cooking pots. From this study, the size of some households in Kilifi County was found to be as large as 21 persons. It is for this reason that some manufacturers have designed new models to address these concerns. For example, Wisdom Innovations developed Model 2-M2 to address the issue of stability and durability, which were concerns in the first model of their stove. BURN manufacturers also introduced the Jikokoa Xtra, which is bigger in size compared to the original Jikokoa. Similarly, Ecozoom introduced a wood stove with a 28 cm diameter, larger than their previous 24 cm model. Ease of operation can also be a technological barrier. This includes factors such as how easy it is to light the stove, the ability to systematically regulate heat and fuel use, partial fuel refill, and the ability to detect the fuel level. Cookstoves that address these factors are highly desired by end-users. Many fuelwood cookstoves do not address these factors.

The choice of cooking technologies and fuels is a composite process with several secondary and tertiary contributing factors. At the heart of the cooking problem is the use of traditional cooking technologies and fuels. Drivers of the prevalent choice of traditional cooking include the high cost of alternatives, limited or non-existent supply chains, lack of awareness, and inappropriate technological design.

5. Supply-chain Barriers

Limited options for dissemination of cookstoves and fuels in the deep rural and remote areas of Kilifi County hinder uptake. Unreliable or unavailable physical infrastructure is a key factor. Apart from kerosene and charcoal, which have fully developed supply chains in the county, other fuels lack well-defined supply chains that reach such areas. Due to this limitation, preferences are set towards technologies that are served by fuels that are readily and consistently available. This is perhaps one of the key hindrances to households purchasing stoves for new and novel forms of fuel, even if these are better suited to their needs.

6. Socio-cultural Factors Influencing Clean Cooking Development

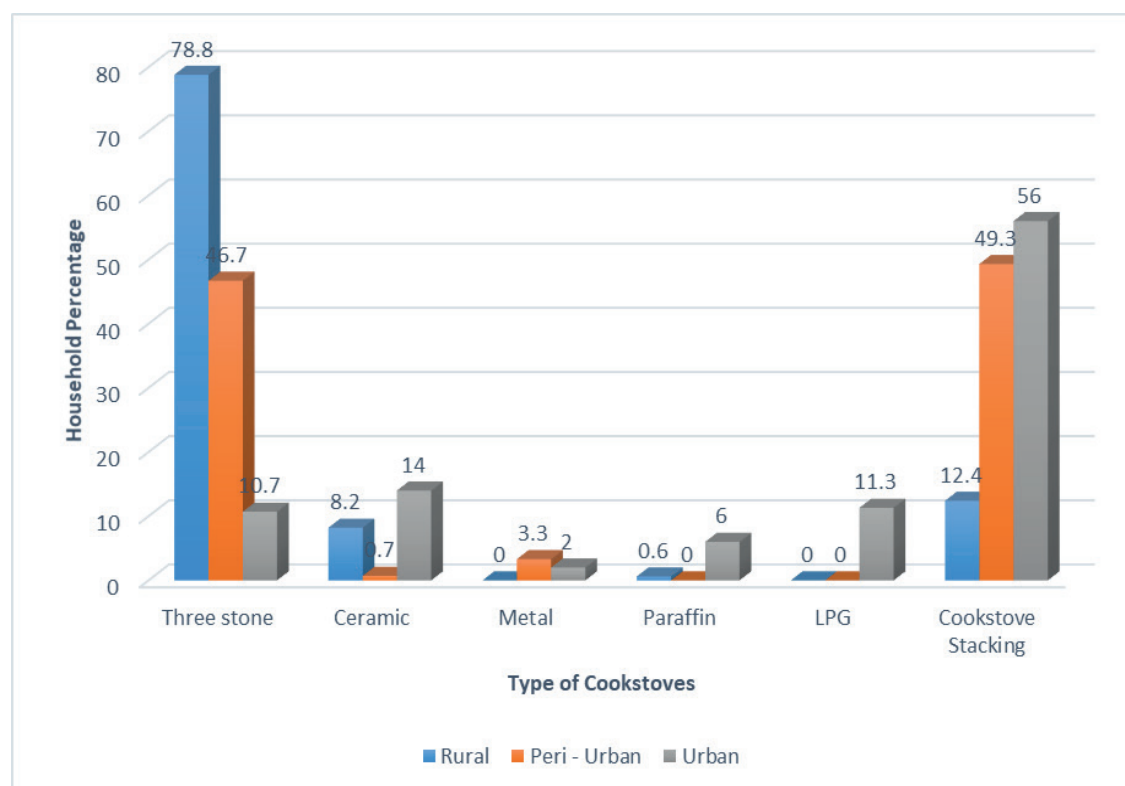
Households often continue to use existing traditional devices or fuels alongside improved cookstoves, and they may revert to traditional methods entirely (Ruiz-Mercado et. al. 2011). Commonly, a stacking of stoves and fuels takes place, with each device being used for cooking practices where it fits best. Therefore, to better understand the adoption process and assess the impacts of introducing a new stove, it is necessary to examine the relative advantages of each device in terms of cooking practices and available fuels. An emerging generation of sensor-based tools makes it possible to continuously and objectively monitor the stove adoption process (from acceptance to sustained use or disadoption). Such behavior is often attributed to issues like fuel cost or social norms such as gender roles. The field report study (Figure 41) confirms that households stack their fuel alongside traditional stoves in Kilifi County. The fuel stacking model suggests that as people become wealthier, they may move from traditional biomass fuels to more advanced and less polluting fuels (e.g., from wood to charcoal, kerosene, and then gas). This practice is more prevalent in urban centers.

Low awareness about the high initial cost of fuel and fear of switching to new technologies and fuels continue to be an impediment to the adoption of ICS. Household sizes in Kilifi County vary greatly, from



1 to 20 persons. Larger families, primarily in peri-urban and rural areas, prefer three-stone cookstoves because most improved cookstoves available in the market are designed to serve smaller households.

Figure 41: Types of Cookstoves Used by Households



Source: (GROOTS Kenya, September 2019)

3.4.6 Cooking and Heating Situations in Institutions

3.4.6.1 Institutions (Learning and Health Institutions)

In this KCEP, institutions are classified into Learning Institutions (ECDEs, Primary and Secondary Schools, and Colleges), Health Facilities (Levels 2, 3, 4, 5, and 6), and Hospitality Facilities, which include hotels, restaurants, and food kiosks. Since the early eighties, the Ministry of Energy, in collaboration with NGOs, UNDP, the private sector, and other stakeholders, has promoted the use of improved stoves. Improved institutional cookstoves can serve as a GHG emission mitigation strategy that simultaneously addresses other developmental challenges in developing countries. Woodfuel consumption rates of between 1.4 and 1.7 kg/cap/year (Kituyi & al, 2001) have been reported for traditional cookstoves in Kenya. These figures are high, largely due to the highly inefficient (5–14% efficiency) traditional cookstoves used in most school kitchens, which also pose significant respiratory health risks for workers. These improved versions have recorded mean consumption rates of 0.35–0.55 kg/cap/day (Kituyi & al, 2001). The improved institutional cookstoves have efficiencies ranging between 40–65% (GoK, Ministry of Energy and United Nations Development Programme, September 2014). To control woodfuel consumption, the Ministry of Energy has drafted regulations to make it mandatory for institutions that use firewood for cooking to install improved institutional stoves (GoK Ministry of Energy—Energy and Petroleum Regulatory Authority, 2012).

It is hoped that the Kilifi Assembly will enact the Kilifi County Energy (Licensing) Regulations 2020 draft, which will eventually be used to enforce the installation of improved institutional biomass cookstoves in Kilifi County. Most institutions use more than one type of cooking technology. A variety of cooking technologies, ranging from the simple three-stone, traditional metal charcoal stoves to improved biomass cookstoves and the more advanced LPG and biogas stoves, are employed. Coupled with the use of different fuels for specific cooking applications, this has resulted in a reliable, cost-effective, and efficient cooking system. The cookstoves are used to prepare different types of food.

i. Learning Institutions

The primary source of cooking and heating fuel in learning institution is firewood. There is high prevalence of dirty fuels and inefficient cooking technologies/ low uptake of modern cooking solutions in county. Learning institutions are major consumers of woodfuel in the County.

1. ECDE

There are 926 ECDCs of which 548 are public and 547 public primary schools in the County. According to the County Directorate of Education, all these public ECDEs and primary school use exclusively firewood in three stone open fire for cooking in temporary kitchens. Average student population ranges between 33 to 73 students. Meals cooked include ten o'clock porridge and at times boiled maize and beans for lunch.

2. Primary Schools

According to county directorate of education, there are a total 165 secondary schools in the county. All this school firewood as the primary source of fuel for cooking. Out of the 165 schools, 101 are cooking with unimproved stoves (type unspecified) in temporary kitchens while 64 are cooking with improved institutional stoves in permanent kitchens.

3. Middle-Level Colleges

As per the county government's department in charge of VTCs, there are 53 VTCs in the county. All these institutions cook with firewood and charcoal as primary and secondary fuels, respectively, in temporary kitchens. For those institutions whose enrollment is provided, the average enrollment per institution is 164. It's assumed, by virtue of the fact that all the institutions are cooking in temporary kitchens, that firewood is being burnt on unimproved stoves and most likely on the 3 stone open fire. The 53 VTCs do not include those run by the National Government.

In March 2024, SETA commissioned a team to carry out a sample survey of energy usage in institutions in Kilifi County, including learning institutions, the hospitality industry, health facilities, and households. The findings of this survey are as follows:

4. Pwani University

This is the only public university in Kilifi County. According to a baseline survey on energy usage, the university has a total of 8,000 students, out of which 2,000 are boarders. The primary source of fuel for cooking is firewood, with LPG as a secondary source. The university uses masonry cookstoves and consumes 300 kg of firewood per day and 13 kg of LPG per week. The university operates full-time for eight months a year, consuming 74.4 tonnes of firewood annually.

ii. Health Facilities

The survey sampled 9 health facilities drawn from levels 2, 3, 4, and 5. Cooking only occurs at levels 3, 4, and 5 facilities. There are 2 level 5 hospitals, 8 level 4 hospitals, and 15 level 3 facilities in the county.



1. Dispensaries (Level 2)

Use LPG exclusively for preparing food (mainly tea) for workers.

2. Health Centres (Level 3)

There are 15 health centers in Kilifi County. These use LPG exclusively for preparing tea for workers, porridge, and hot water for bathing newborn babies and mothers. However, one level 3 facility uses charcoal, LPG, and an electric kettle for cooking and heating.

3. Sub-County and County Referral Hospitals (Levels 4 and 5)

These health facilities admit inpatients and prepare food for them. The survey indicated Kilifi County Hospital uses firewood as the main source of fuel for cooking in masonry cookstoves, while Mariakani Sub-county Hospital uses LPG exclusively for cooking. Mtwapa Sub-county Hospital uses LPG as the primary cooking fuel, while Bamba Sub-county Hospital uses LPG primarily and charcoal secondarily. Apart from Kilifi County Hospital, the rest of levels 4 and 5 use LPG as the main fuel for cooking. From the survey, the price of firewood varied between KES 10–15 per kg, and between KES 20–25 per kg for charcoal. Kilifi Sub-County Hospital, which consumes 300 kg of firewood, spends an average of KES 3,750 per day (KES 112,500 per month). Mariakani spends KES 27,000 per week (KES 108,000 per month).

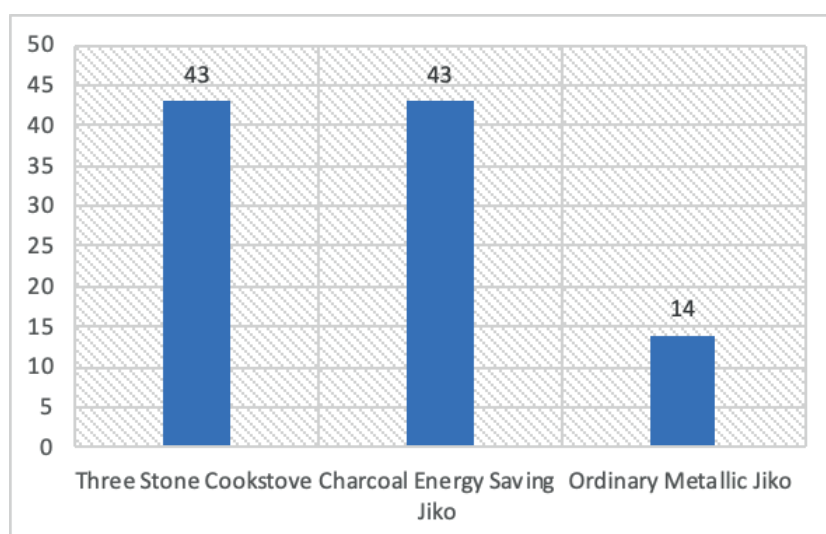
iii. Hospitality Facilities

For the hospitality industry, the facilities were categorised into three classes: Food kiosks/vibandas, Restaurants, and Star hotels.

1. Food Kiosks/vibandas

The sample indicated that food kiosks and vibanda eateries cook using firewood or charcoal. Vibanda eateries are more informal, operating under temporary structures or open spaces, and most of them cook using firewood on a three-stone cookstove. Food kiosks were found to be using either firewood as the primary cooking fuel and charcoal as secondary or vice versa. Figure 42 shows the cooking solutions used in food kiosks/vibanda eateries.

Figure 42: Cooking Technologies used in Food Kiosks/Vibanda Eateries

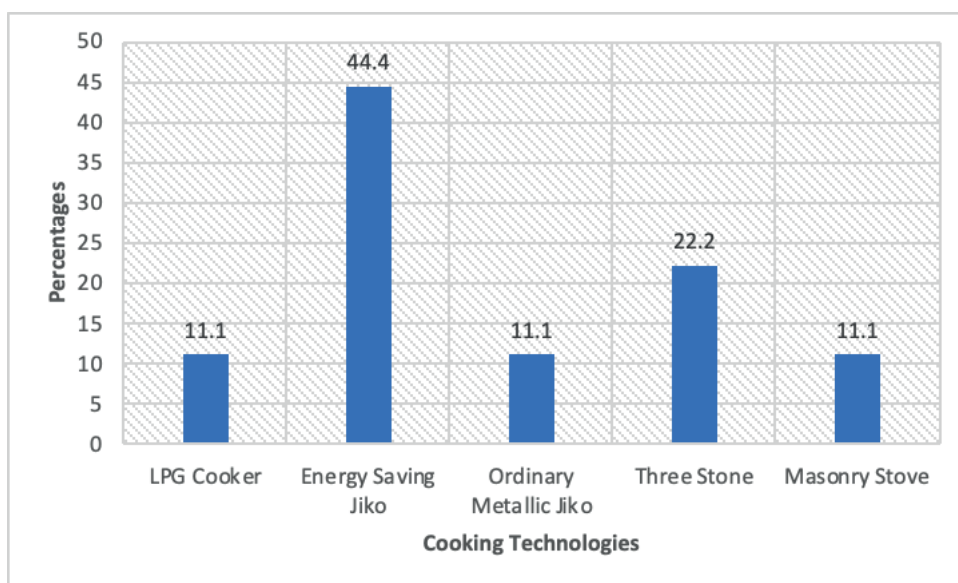


Source: (Kilifi County—SETA Team, August 2023)

2. Restaurant

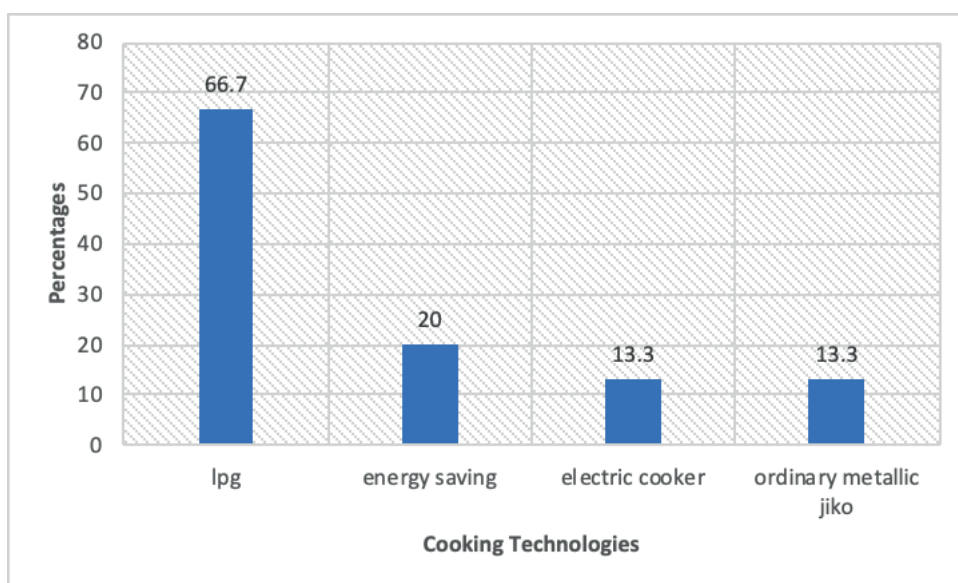
Restaurants are more advanced than food kiosks and operate in permanent buildings. The use of different cooking solutions for restaurants is shown in the figures below.

Figure 43: Primary Cooking Technologies in Restaurants



Source: (Kilifi County—SETA Team, August 2023)

Figure 44: Secondary Cooking Technologies in Restaurants



Source: (Kilifi County—SETA Team, August 2023)



3. Star Hotels

For the 3- and 4-star hotels sampled, all were using LPG and charcoal as the primary cooking fuels. Charcoal was mainly used for roasting meat. It is notable that one of the hotels was using solar water heaters.

3.4.7 Pathways for Access to Clean Cooking Solutions

In rural areas, the focus is on the very poor efficiency of firewood use, 80% of which is collected by farmers. The fact that Kilifi's population relies on rural woody resources for more than 85% of their needs highlights the urgency to increase and secure the sustainability of woody and forestry resources during the transition away from charcoal and firewood.

- Sensitisation campaigns on the sustainable use and management of woody resources and forests,
- Mapping of charcoal production and the development of a strategy to progressively phase out this production (charcoal requires approximately 6–7 tonnes of wood to produce 1 tonne of charcoal, depending on the efficiency of carbonization—15% to 18%),
- Promoting woodlots and tree planting on farms,
- Enforcing existing regulations (10% of farm area covered by trees),
- Curbing the use of charcoal, particularly among new consumers (urban populations) who may find it easier to adopt charcoal if firewood becomes scarce,
- Promoting LPG and ethanol as substitute clean cooking fuels,
- Promoting e-cooking for those who have already adopted LPG but use charcoal as a primary or secondary fuel,
- Advocating for the use of firewood and charcoal ICS for those who continue to use these fuels,
- Exploring payment models/options for stove acquisition:
 1. Cash-based models;
 2. Pay-as-you-go business model;
 3. Lay-away business model;
 4. Distribution through organised groups
- Promoting private sector participation in energy production, distribution, and marketing,
- Offering training opportunities for Jua Kali artisans at the village level for the manufacture, installation, and maintenance of renewable energy technologies, including efficient cookstoves,
- Licensing charcoal production to encourage its commercial production in a sustainable manner,
- Installing solar water heaters,
- Installing biogas plants in institutions with livestock on their farms.
- It is proposed to install Improved Cookstoves (1 Bellerive model) and to modernize the kitchens in all learning institutions using three-stone cookstoves.
- Schools with enrollment above 700 can also be considered for human waste biogas systems. Borrowing from secondary schools in the county that have installed human waste biogas systems, this biogas could provide secondary fuel, with firewood still being the primary fuel.



3.4.8 Envisioned Progression to Clean Cooking Solutions

3.4.8.1 Total Energy Demand Comparison Under Different Scenarios

Three scenarios, as indicated in Figure 50, have been developed for the purposes of the county energy plan:

- Baseline or business as usual—without intervention from the county,
- The policy scenario based on the discussion of the expected transitional pathways to a cleaner situation
- The SDG7 scenario, proposing a clean cooking situation by 2028, by totally offsetting the use of firewood and charcoal.

Figure 45 : Energy Demand Comparison for All Scenarios

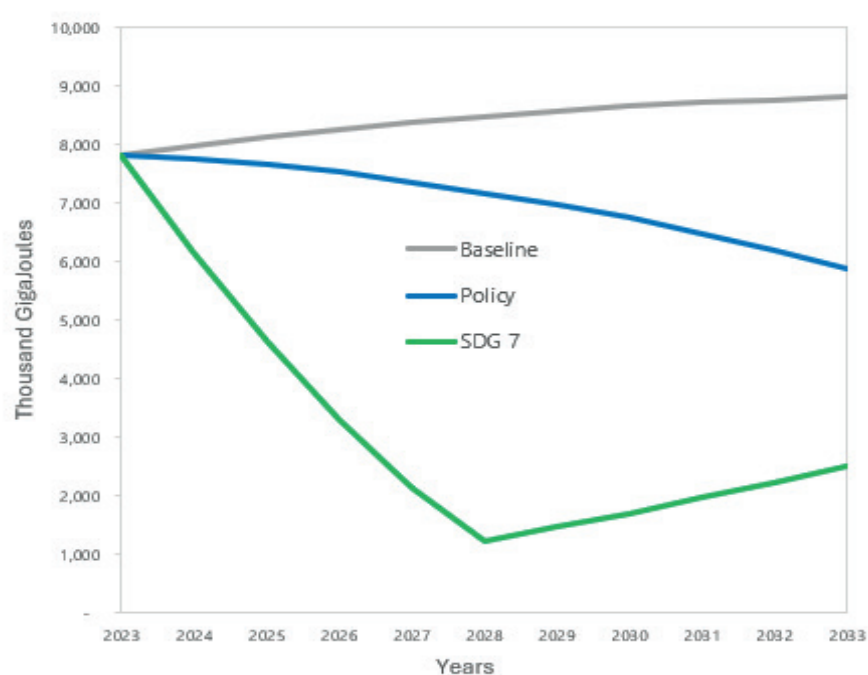


Table 76: Cooking fuels demand in GJ in the three scenarios

Scenario Year	2023	2028	2033
Baseline in GJ	7835,000	8484,000	8811,000
Policy in GJ	7835,000	7163,000	5879,000
SDG 7 in GJ	7835,000	1241,000	2507,000

Source: Author

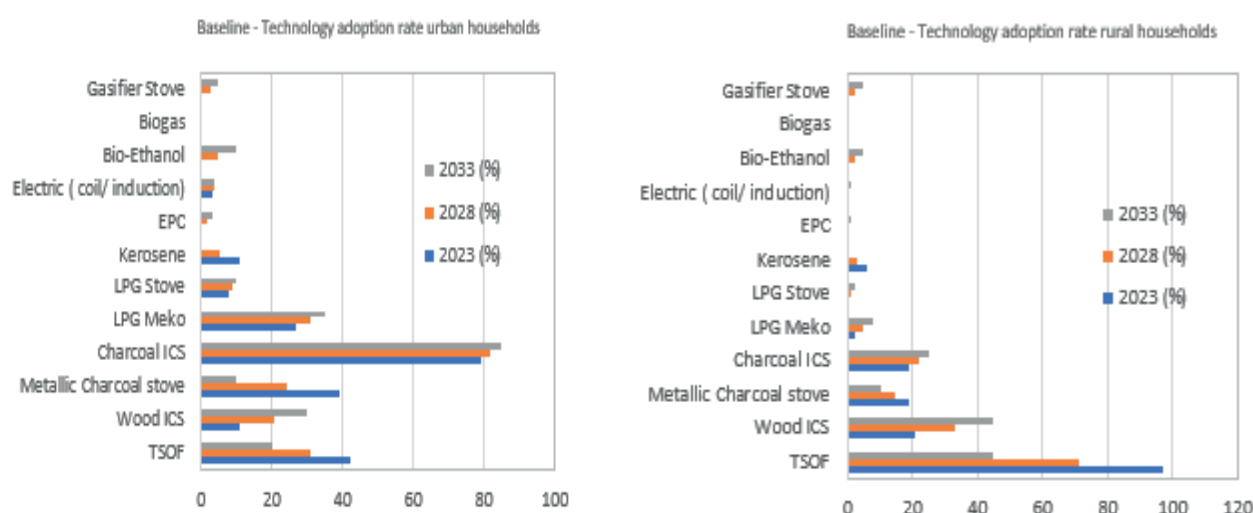


3.4.8.1.1 Baseline Scenario

Table 77: Technology Adoption Rate – Urban and rural (Baseline Scenario)

Technology	Urban			Rural		
	2023 (%)	2028 (%)	2033 (%)	2023 (%)	2028 (%)	2033 (%)
TSOF	42	31	20	97	71	45
Wood ICS	11	20.5	30	21	33	45
Metallic Charcoal stove	39	24.5	10	19	14.5	10
Charcoal ICS	79	82	85	19	22	25
LPG Meko	27	31	35	2	5	8
LPG Stove	8	9	10	-	1	2
Kerosene	11	5.5	-	6	3	-
EPC	-	1.5	3	-	0.5	1
Electric Stove (coil/ induction cookers)	3	3.5	4	-	0.5	1
Bio-Ethanol	-	5	10	-	2.5	5
Biogas	-	-	-	0.1	0.2	0.3
Gasifier Stove		2.5	5	-	2.5	5

Figure 46: Technology Adoption Rate Urban and Rural Households



Source: Author

Under the baseline scenario, firewood and charcoal continue to play a key role in Kilifi's cooking ecosystem. However, current initiatives such as the zero-rating of VAT on LPG and the Behavioral Change Campaign are shifting the adoption towards Improved Cookstoves and briquettes. LPG uptake/consumption increases, ethanol and Electric Pressure Cookers (EPCs) are introduced and grow steadily. An average of 10–15 biogas plants are built per year to raise the number of domestic biogas plants to 220 by 2033, up from 53¹³ in 2021.

¹³ ABPL 2021 data

Figure 47: Energy Demand Under Baseline Scenario (2023–2033)

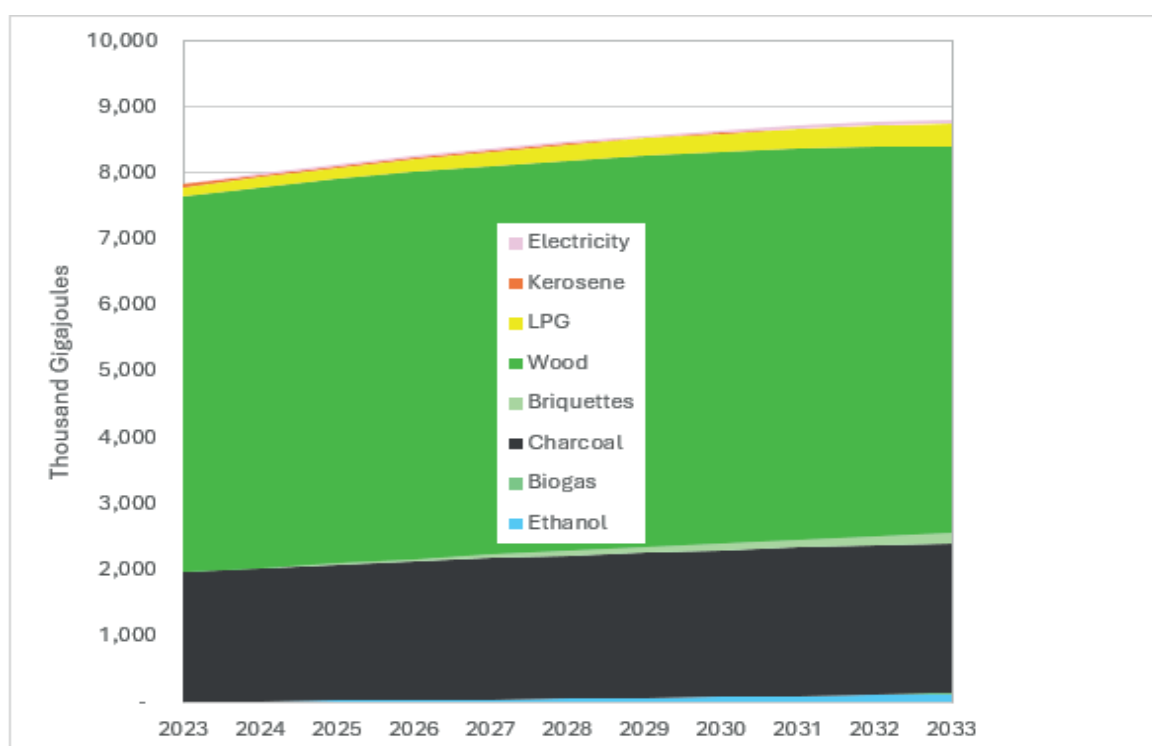


Table 78: Summary of Fuel Demand under Baseline Scenario (2023–2033)

Fuel	2023	2028	2033
Firewood (Tonnes)	366,314	381,537	378,351
Charcoal (Tonnes)	68,033	74,987	78,508
LPG (Tonnes)	3,089	4,992	7,353
Kerosene (1,000 L)	952	590	-
Electricity (MWh)	2,831	7,521	13,789
Ethanol (1,000 L)	-	2,135	5,101
Biogas (1,000 M³)	94	181	285
Briquettes (Tonnes)		3,056	7,185

Source: Author



3.4.8.1.2 Policy Scenario

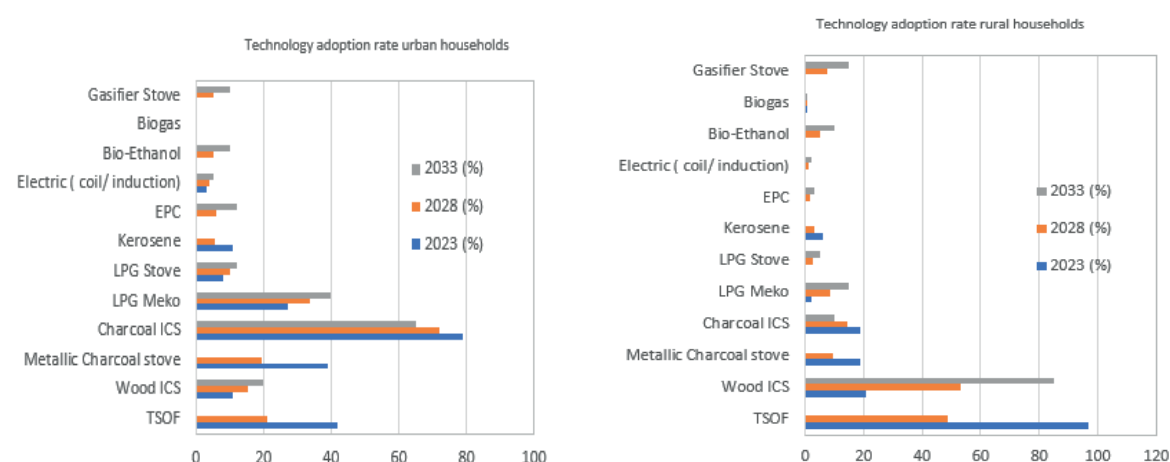
Under the policy scenario, there's a major transition to Improved Cookstoves, with measures to balance supply and demand for biomass resources, including mapping charcoal production and developing a strategy to progressively phase out charcoal production. The enforcement of existing regulations (10% of farm area to be covered by trees) will also be prioritized. The county revives the briquetting project through investment in Operation & Maintenance (O&M) of assets to complement private sector production.

Clean cooking solutions such as LPG, electric cooking, ethanol, and biogas are promoted and grow steadily. The target is to increase by 50 biogas plants per year, reaching 587 plants (0.8% of rural households) by 2033.

Table 79: Technology Adoption Rate—Urban and Rural (Policy Scenario)

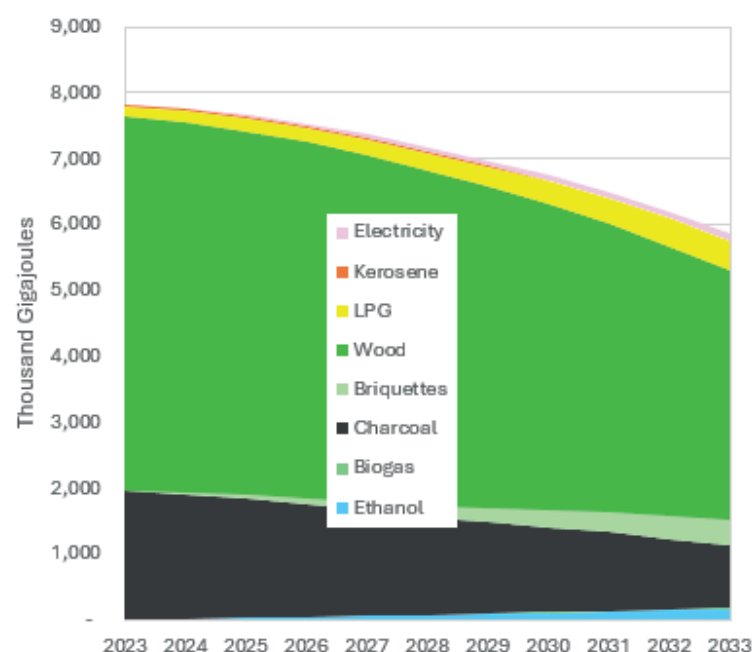
Technology	Urban			Rural		
	2023 (%)	2028 (%)	2033 (%)	2023 (%)	2028 (%)	2033 (%)
TSOF	42	21	-	97	48.5	-
Wood ICS	11	15.5	20	21	53	85
Metallic Charcoal stove	39	19.5	-	19	9.5	-
Charcoal ICS	79	72	65	19	14.5	10
LPG Meko	27	33.5	40	2	8.5	15
LPG Stove	8	10	12	-	2.5	5
Kerosene	11	5.5	-	6	3	-
EPC	-	6	12	-	1.5	3
Electric (coil/induction)	3	4	5	-	1	2
Bio-Ethanol	-	5	10	-	5	10
Biogas	-	-	-	0.1	0.5	0.8
Gasifier Stove	-	5	10	-	7.5	15

Figure 48: Technology Adoption rates Urban and Rural Households



Source: Author

Figure 49: Energy Demand under Policy Scenario (2023–2033)



The projection in the policy scenario is that the demand of wood (firewood and charcoal feedstock) is expected to reduce by 360,000 tonnes by 2033. LPG demand increases by 6,000 tonnes. The demand for electricity increases significantly to 33,000MWh, whereas ethanol demand is expected to reach 7 million litres by 2033.

Table 80: Summary of Fuel Demand under Policy Scenario (2023–2033)

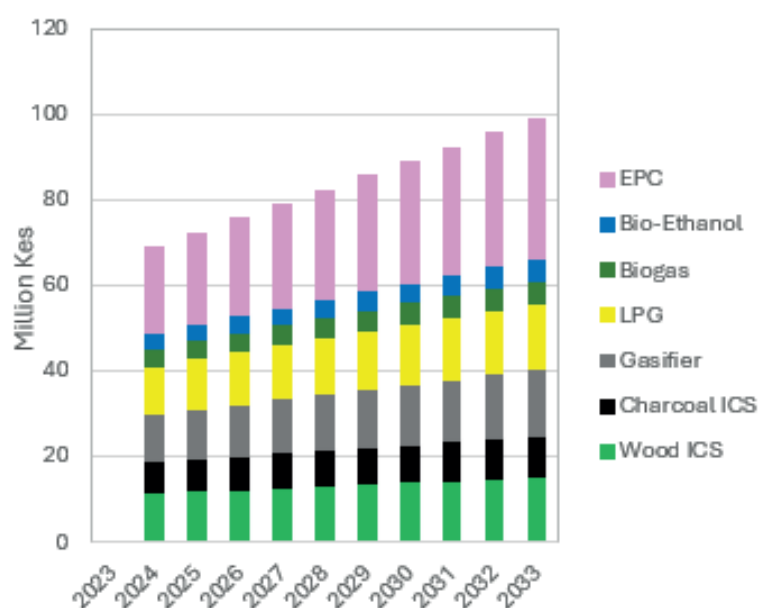
Fuel	2023	2028	2033
Firewood (Tonnes)	366,314	327,255	243,628
Charcoal (Tonnes)	68,033	51,167	32,553
LPG (Tonnes)	3,089	6,032	9,784
Kerosene (1,000 L)	952	590	-
Electricity (MWh)	2,831	15,466	32,969
Ethanol (1,000 L)	-	3,022	7,104
Biogas (1,000 M³)	94	392	761
Briquettes (Tonnes)	-	7,907	18,422

Source: Author

An analysis of the investment requirements to actualize the policy scenario shows an average annual requirement of KES 70 Million as shown Figure 55.



Figure 50: Level of Investment Required for Technology Acquisition



Source: Author

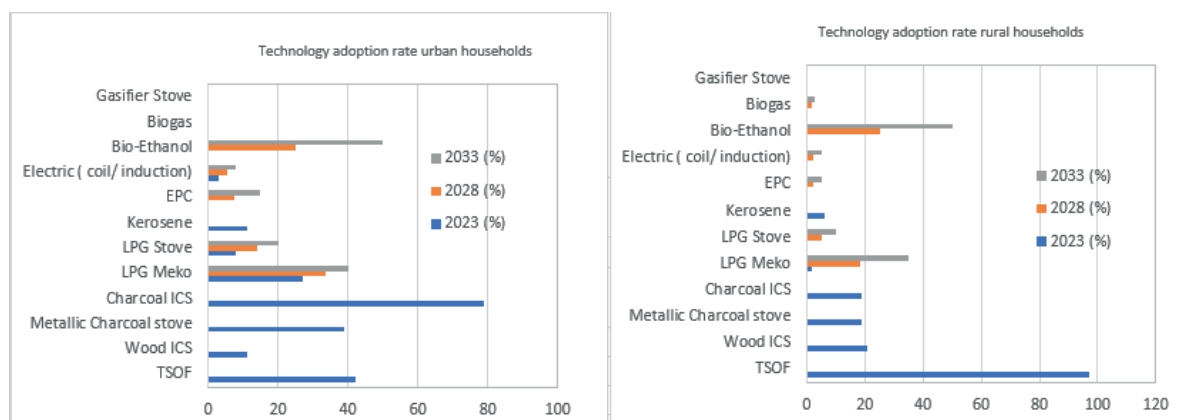
3.4.8.1.3 SDG No. 7 Scenario

This scenario aims to achieve the SEforALL target of universal access to clean and modern cooking energy by 2030. It seeks to phase out unsustainable solid biomass and traditional cookstoves, by 2030. Modern energy cooking solutions, such as LPG, bioethanol, electricity, and biogas, will be adopted as the primary mode of cooking across all sectors.

Table 81: Technology Adoption Rate—Urban and Rural (SDG Scenario)

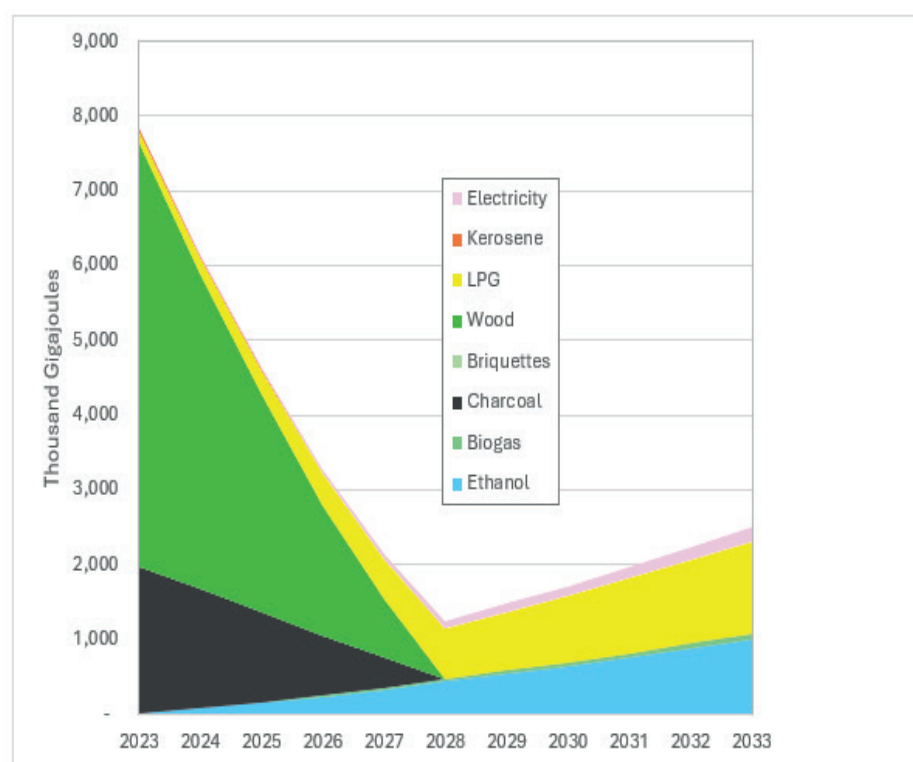
Technology	Urban			Rural		
	2023 (%)	2028 (%)	2033 (%)	2023 (%)	2028 (%)	2033 (%)
TSOF	42	-	-	97	-	-
Wood ICS	11	-	-	21	-	-
Metallic Charcoal stove	39	-	-	19	-	-
Charcoal ICS	79	-	-	19	-	-
LPG Meko	27	33.5	40	2	18.5	35
LPG Stove	8	14	20	-	5	10
Kerosene	11	-	-	6	-	-
EPC	-	7.5	15	-	2.5	5
Electric (coil/induction)	3	5.5	8	-	2.5	5
Bio-Ethanol	-	25	50	-	25	50
Biogas	-	-	-	0.1	1.6	3
Gasifier Stove	-	-	-	-	-	-

Figure 51: Technology Adoption Rates Urban and Rural Households



Source: Author

Figure 52: Energy Demand Under the SDG Scenario (2023–2033)



3.4.8.2 Progression in Adoption of Clean Cooking Solutions in Education Institutions

1. Adoption of Clean Cooking Fuels

Year		2023	2024	2025	2026	2027	2028
No. of ECDEs		946	946	946	946	946	946
Firewood	%	100	100	100	95	90	80
	No.	946	946	946	899	851	757
LPG	%	0	0	0	5	10	20
	No.	0	0	0	47	95	189
No. of Primary schools		559	559	559	559	559	559
Firewood	%	100	100	100	95	90	80
	No.	559	559	559	531	503	447
LPG	%	0	0	0	5	10	20
	No.	0	0	28	56	112	
No. of Secondary schools		132	132	132	132	132	132
Firewood	%	100	100	100	93	87	75
	No.	132	132	132	123	115	99
Biogas	%	0	0	0	2	3	5
	No.	0	0	0	3	4	7
LPG	%	0	0	0	5	10	20
	No.	0	0	0	7	13	26
No. of Tertiary institutions		53	53	53	53	53	53
Firewood	%	100	100	100	93	87	75
	No.	53	53	53	50	47	41
Biogas	%	0	0	0	2	3	5
	No.	53	53	53	1	2	3
LPG	%	0	0	0	5	10	20
	No.	53	53	53	3	5	11

Source: Author

2. Adoption of Efficient Cooking Devices

Year		2023	2024	2025	2026	2027	2028
No. of ECDEs		946	946	946	946	946	946
Three Stones Open Fire	%	100	100	90	65	50	0
	No.	946	946	851	614	473	0
Improved institutional stoves	%	0	0	10	30	40	80
	No.	0	0	95	284	378	757
LPG stoves	%	0	0	0	5	10	20
	No.	0	0	0	47	95	189
No. of Primary schools		559	559	559	559	559	559
Three Stones Open Fire	%	100	100	80	50	25	0
	No.	559	559	447	280	140	0
Improved institutional stoves	%	0	0	0	45	65	80
	No.	0	0	0	252	363	447
LPG stoves	%	0	0	0	5	10	20
	No.	0	0	0	28	56	112
No. of Secondary schools		132	132	132	132	132	132
Three Stones Open Fire	%	76	70	50	25	10	0
	No.	101	92	66	33	13	0
Improved institutional stoves	%	24	30	50	70	80	80
	No.	31	40	66	92	106	106
LPG stoves	%	0	0	0	5	10	20
	No.	0	0	0	7	13	26
No. of Tertiary institutions		53	53	53	53	53	53
Three Stones Open Fire	%	100	94	75	38	19	0
	No.	53	50	40	20	10	0
Improved institutional stoves	%	0	6	25	60	71	80
	No.	0	3	13	33	38	42
LPG stoves	%	0	0	0	2	10	20
	No.	0	0	0	3	5	11



3.4.8.3 Envisioned progression to clean cooking solutions in Hospitality Industry

1. Adoption of Primary Clean Fuels

Year	2024	2025	2026	2027	2028
Restaurants					
Firewood %	23.0	20	15	10	0
Charcoal %	38.5	30	20	10	5
LPG %	38.5	49	63	75	85
Electricity %	0	1	2	5	10

Source: Author

2. Adoption of Clean & Efficient Cooking Devices

Year	2023	2024	2025	2026	2027	2028
Food Kiosks/Vibandas						
Three Stones Open Fire primary & Traditional Metallic Charcoal Stoves Secondary %	43	40	30	20	10	0
Improved cookstoves %	0	5	15	20	25	30
Energy saving charcoal %	57	48	26	35	30	25
LPG %	0	5	15	20	25	30
Electricity %	0	2	4	5	10	15
Total	57	60	70	80	90	100
Restaurants						
LPG %	40	45	50	55	60	65
Firewood Masonry jiko %	30	25	20	10	5	0
Energy saving %	30	28	24	30	18	25
Electricity %	0	2	4	5	7	10

Source: Author

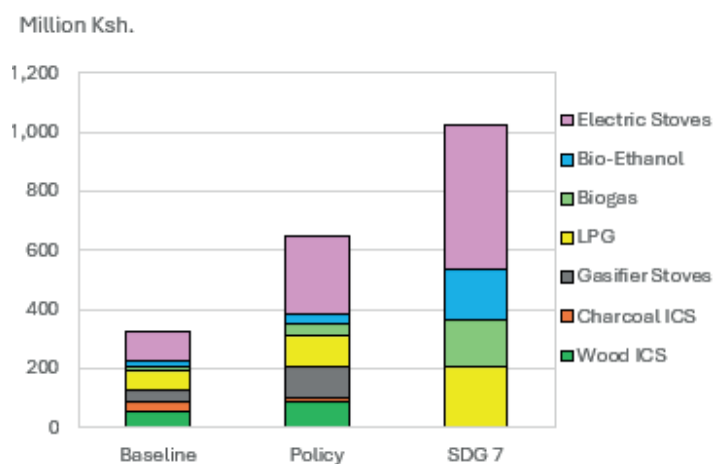
3.4.9 Estimated Investments for Modern Cooking Solutions

3.4.9.1 Households

To compare the scenarios, the investments for each technology has been calculated year by year and consolidated as a net present value at a discount rate of 4%.

The discount rate may reflect the cost of capital or the returns available on alternative investments of comparable risk. A low discount rate is selected due to the social dimension of the cooking sector and prioritized more long term strategy (longer period of return on investment).

Figure 53: NPV of the Investments in the Three Scenarios

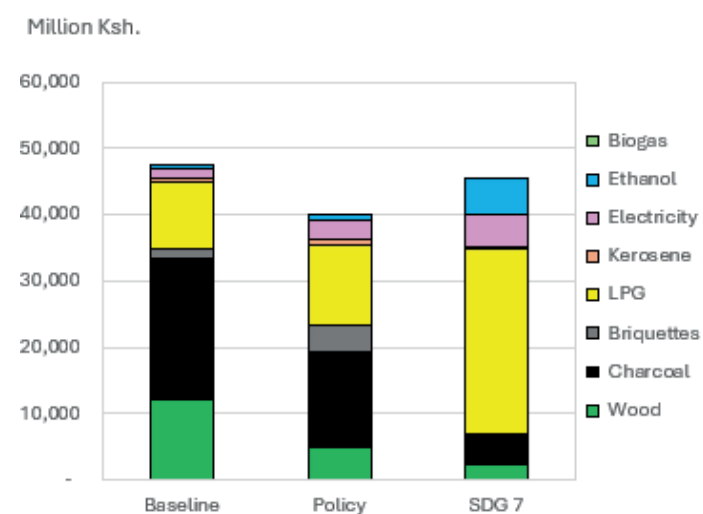


Technology	Cost Million (Ksh.)		
	Baseline	Policy	SDG 7
Wood ICS	52	90	-
Charcoal ICS	36	8	-
LPG	64	108	204
Biogas	11	39	162
Bio-Ethanol	25	35	173
Electric Stoves	98	261	489
Gasifier Stoves	42	107	-
Total (Kshs)	326	647	1,028
Total (USD)	2	4	7

Source: Author

Cooking Fuel Expenses Analysis

Figure 54: Discounted fuel expenses for 2024–2033



Fuel	Cost Million (Ksh.)		
	Baseline	Policy	SDG 7
Wood	12,165	4,948	2,288
Charcoal	21,180	14,449	4,510
LPG	10,011	12,231	28,088
Kerosene	716	716	318
Electricity	1,423	2,998	4,868
Ethanol	632	889	5,269
Briquettes	1,499	3,864	-
Biogas	-	-	-
	47,626	40,096	45,342

Source: Author

Investment Progressions in Different Scenarios

Table 82: Firewood ICS Investment (Policy Scenario)

Branch	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Households (Thousands HH)	104	107	109	112	114	117	120	122	125	127	130
Urban HH	40,522	42,030	43,562	45,117	46,697	48,301	49,929	51,581	53,256	54,956	56,680
Rural HH	63,381	64,483	65,561	66,615	67,645	68,651	69,632	70,590	71,524	72,434	73,320
Rural HH ICS Penetration	13,310	17,668	22,160	26,779	31,522	36,385	41,362	46,448	51,641	56,933	62,322
Annual Increment		4,358	4,491	4,620	4,743	4,862	4,977	5,087	5,192	5,293	5,389
Cost of ICS/Stove (KES)	2,000										
Cost of ICS KES Million/Year (Rural)		9	9	9	9	10	10	10	10	11	11
Urban HH ICS Penetration	4,457	5,002	5,576	6,181	6,818	7,487	8,188	8,923	9,693	10,497	11,336
Annual Increment		544	574	605	637	669	702	735	769	804	839
Cost of ICS KES Million/Year (Urban)		1	1	1	1	1	1	1	2	2	2
Total Costs	NPV 90	10	10	10	11	11	11	12	12	12	12

Source: Author

Table 83: Charcoal ICS Investment

Branch	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Total Households (Thousands)	104	107	109	112	114	117	120	122	125	127	130
Urban HH	40,522	42,030	43,562	45,117	46,697	48,301	49,929	51,581	53,256	54,956	56,680
Rural HH	63,381	64,483	65,561	66,615	67,645	68,651	69,632	70,590	71,524	72,434	73,320
Rural HH Charcoal ICS Penetration	12,042	11,671	11,276	10,858	10,417	9,954	9,470	8,965	8,440	7,895	7,332
Annual Increment		-371	-395	-418	-441	-463	-484	-505	-525	-545	-563
Cost of Charcoal ICS (KES)	2,000										
Cost of Charcoal ICS KES Million/Year (Rural)		-1	-1	-1	-1	-1	-1	-1	-1	-1	-1
Urban HH Charcoal ICS Penetration	32,013	32,615	33,194	33,748	34,276	34,777	35,250	35,694	36,108	36,491	36,842
Annual Increment		603	579	554	528	501	473	444	414	383	351
Cost of Charcoal ICS KES Million/Year (Urban)		1	1	1	1	1	1	1	1	1	1
Total No. of New Charcoal ICS Stoves		603	579	554	528	501	473	444	414	383	351
Total Costs (KES Million)/Year	NPV 8	1	1	1	1	1	1	1	1	1	1

Source: Author

Table 84: Gasifier Investment (Policy Scenario)

Branch	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Households	104	107	109	112	114	117	120	122	125	127	130
Total	104	107	109	112	114	117	120	122	125	127	130
Urban HH	40,522	42,030	43,562	45,117	46,697	48,301	49,929	51,581	53,256	54,956	56,680
Rural HH	63,381	64,483	65,561	66,615	67,645	68,651	69,632	70,590	71,524	72,434	73,320
Rural Gasifier Penetration	-	967	1,967	2,998	4,059	5,149	6,267	7,412	8,583	9,779	10,998
Annual Increment		967	1,000	1,031	1,061	1,090	1,118	1,145	1,171	1,196	1,219
Cost of Gasifier (KES)	8,000										
Cost of Gasifier KES Million/Year (Rural)		8	8	8	8	9	9	9	9	10	10
Urban HH Gasifier Penetration	-	420	871	1,354	1,868	2,415	2,996	3,611	4,261	4,946	5,668
Annual Increment		420	451	482	514	547	581	615	650	686	722
Cost of Gasifier KES Million/Year (Urban)		3	4	4	4	4	5	5	5	5	6
Total No. of Gasifier Stoves		1,388	1,451	1,513	1,575	1,637	1,699	1,760	1,821	1,881	1,941
Total Costs (KES Million)/Year	NPV 107	11	12	12	13	13	14	14	15	15	16

Source: Author

Table 85: LPG Investment Cost

Branch	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Total Households (Thousands)	104	107	109	112	114	117	120	122	125	127	130
Urban HH	40,522	42,030	43,562	45,117	46,697	48,301	49,929	51,581	53,256	54,956	56,680
Rural HH	63,381	64,483	65,561	66,615	67,645	68,651	69,632	70,590	71,524	72,434	73,320
Rural HH Meko Penetration	1,268	2,128	3,016	3,930	4,870	5,835	6,824	7,836	8,869	9,923	10,998
Annual Increment		860	888	914	940	965	989	1,012	1,033	1,054	1,075
Rural 13 kg Penetration	-	322	656	999	1,353	1,716	2,089	2,471	2,861	3,260	3,666
Annual Increment		322	333	344	354	363	373	382	390	399	406
6 kg Cylinder + Gas	3,390										
13 kg Cylinder + Gas + 2 Burner Stove	8,580										
Meko Investment KES Million/Year		3	3	3	3	3	3	3	4	4	4



Branch	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
13 kg Investment KES Million/Year		3	3	3	3	3	3	3	3	3	3
Total (Rural)	Total	6	6	6	6	6	7	7	7	7	7
Urban HH Meko Penetration	10,941	11,894	12,894	13,941	15,036	16,181	17,375	18,621	19,918	21,268	22,672
No. of new cylinder		953	1,000	1,047	1,095	1,144	1,194	1,245	1,297	1,350	1,404
Urban HH 13 kg Penetration	3,242	3,531	3,833	4,151	4,483	4,830	5,193	5,571	5,965	6,375	6,802
No. of new cylinder		289	303	317	332	347	362	378	394	410	427
Meko Investment KES Million/Year		3	3	4	4	4	4	4	4	5	5
13 kg Investment KES Million/Year		2	3	3	3	3	3	3	3	4	4
Total (Urban)	Total	6	6	6	7	7	7	7	8	8	8
Total No. of New Cylinders (Meko)		1,814	1,888	1,962	2,035	2,109	2,183	2,257	2,331	2,405	2,478
Total No. of New Cylinders (13 kg)		611	636	661	686	711	735	760	784	809	833
Total Investment Cost KES Million/Year (Meko)		6	6	7	7	7	7	8	8	8	8
Total Investment Cost KES Million/Year (13 kg Cylinder + Stove)		5	5	6	6	6	6	7	7	7	7
Total Investment Cost KES Million/Year	NPV 108	11	12	12	13	13	14	14	15	15	16

Source: Author

Table 86: Biogas Investment (Policy Scenario)

Branch	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Total Households (Thousands)	104	107	109	112	114	117	120	122	125	127	130
Urban HH	40,522	42,030	43,562	45,117	46,697	48,301	49,929	51,581	53,256	54,956	56,680
Rural HH	63,381	64,483	65,561	66,615	67,645	68,651	69,632	70,590	71,524	72,434	73,320
Rural HH Biogas Penetration	82	127	173	220	269	319	370	423	476	531	587
Annual Increment		45	46	47	49	50	51	52	54	55	56
Cost of 8M3 domestic biogas system (KES)	95,000										
Cost of Biogas System KES Million/Year	NPV 39	4	4	5	5	5	5	5	5	5	5

Source: Author

Table 87: Bio-Ethanol Investment (Policy Scenario)

Branch	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Total Households (Thousands)	222	227	232	238	243	249	255	261	267	273	279
Urban HH	86,440	89,596	92,803	96,059	99,365	102,721	106,375	110,085	113,851	117,671	121,547
Rural HH	135,200	137,459	139,669	141,828	143,938	145,997	148,355	150,657	152,903	155,095	157,231
Rural HH Bio-Ethanol Penetration	-	1,375	2,793	4,255	5,758	7,300	8,901	10,546	12,232	13,959	15,723
Annual Increment		1,375	1,419	1,461	1,503	1,542	1,601	1,645	1,686	1,726	1,765
Cost of Bio-Ethanol Stove (KES)	1,550										
Cost of Bio-Ethanol Stove KES Million/Year (Rural)		2	2	2	2	2	2	3	3	3	3
Urban HH Bio- Ethanol Penetration	-	896	1,856	2,882	3,975	5,136	6,383	7,706	9,108	10,590	12,155
Annual Increment		896	960	1,026	1,093	1,161	1,246	1,323	1,402	1,482	1,564
Cost of Bio-Ethanol Stove KES Million/Year (Urban)		1	1	2	2	2	2	2	2	2	2
Total Costs (KES Million)/ Year	NPV 35	4	4	4	4	4	4	5	5	5	5

Source: Author

Table 88: Electric Pressure Cooking (EPC) Investment (Policy Scenario)

Branch	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Total Households (Thousands)	222	227	232	238	243	249	255	261	267	273	279
Urban HH	86,440	89,596	92,803	96,059	99,365	102,721	106,375	110,085	113,851	117,671	121,547
Rural HH	135,200	137,459	139,669	141,828	143,938	145,997	148,355	150,657	152,903	155,095	157,231
Rural HH EPC Penetration	-	412	838	1,276	1,727	2,190	2,670	3,164	3,670	4,188	4,717
Annual Increment		412	426	438	451	463	480	493	506	518	529
Cost of EPC (KES)	13,500										
Cost of EPC (KES Million)/ Year (Rural)		6	6	6	6	6	6	7	7	7	7



Branch	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Urban HH EPC Penetration	-	1,075	2,227	3,458	4,770	6,163	7,659	9,247	10,930	12,708	14,586
Annual Increment		1,075	1,152	1,231	1,311	1,394	1,496	1,588	1,682	1,779	1,877
Cost of EPC (KES Million)/ Year (Urban)		15	16	17	18	19	20	21	23	24	25
Total Costs (KES Million)/ Year	NPV 208	20	21	23	24	25	27	28	30	31	32

Source: Author

3.4.9.2 Investments in Learning Institutions

1. ECDEs

It's proposed to install Improved Cookstoves (1 Bellerive model) and to modernize the kitchens in all 926 ECDEs.

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
Bellerive institutional stoves	100 liters (150–200 students)	200,000	926	185,200,000
Modern kitchens		5,000,000	926	4,630,000,000
Total				4,815,200,000

Installing Improved cookstoves (Bellerive models) at the 223 schools using the old boiler stove and installation of human waste biogas systems in 12 schools with enrollment above 700, and modernizing the kitchens in 223 schools.

Enrollment band	No. of schools	Institutional stove specifications	Unit cost in KES	Total cost in KES
21–100	32	100 litres	200,000	6,400,000
101–200	83	100 litres	200,000	16,600,000
201–350	63	200 litres	250,000	15,750,000
351–700	33	350 litres	300,000	9,900,000
701–800	4	400 litres	350,000	1,400,000
801–1000	5	500 litres	400,000	2,000,000
Above 1000	3	800 litres	450,000	1,350,000
Total	223			53,400,000
Modern kitchens	223		5,000,000	1,115,000,000
Grand Total				1,168,400,000

2. Secondary Schools

Installing Improved cookstoves (Bellerive models) at the 101 schools using non-improved stoves and modernizing the kitchens, and installation of human waste biogas systems in 32 schools with enrollment above 700.

Enrollment band	No. of schools	Institutional stove specifications	Unit cost in KES	Total cost in KES
21–100	3	100 litres	200,000	600,000.00
101–200	14	100 litres	200,000	2,800,000.00
201–350	23	200 litres	250,000	5,750,000.00
351–700	35	350 litres	300,000	10,500,000.00
701–800	6	400 litres	350,000	2,100,000.00
801–1000	4	500 litres	400,000	1,600,000.00
Above 1000	16	800 litres	450,000	7,200,000.00
Total	101			30,550,000.00
Modern Kitchen	101		5,000,000	505,000,000.00
Biogas	32	72 cubic metres	4,000,000	128,000,000.00
Grand Total				663,550,000.00

3. Vocational and Technical College (VTC)

The recommended solutions are as follows:

1. Install improved institutional stoves in all the 53 VTCs.
2. Install human waste biogas systems in the 4 VTCs with enrollments above 500.
3. Potentially displace charcoal with electric cooking at the 34 VTCs cooking with charcoal as a secondary fuel and which are connected to grid power.

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
Bellerive institutional stoves	200 liters	250,000	47	11,750,000
Bellerive institutional stoves	350 liters	300,000	6	1,800,000
Human waste biogas systems	72 cubic metres	4,000,000	4	16,000,000
Total				29,550,000

3.4.10 Barriers, risks, and mitigation measures

- High capex costs for biogas digesters inhibit affordability. This can be addressed through leveraging strategic partnerships and innovative delivery models.
- Beliefs and myths: Misconceptions that biogas from human waste can contaminate food. To address this, it's crucial to provide education and awareness about the scientific process behind biogas production and emphasize safety measures. Highlighting successful examples of similar systems can dispel myths and build confidence in the technology's reliability and safety.



- High capital expenditure for Landfill Gas (LFG) project—The county government will leverage on PPP opportunities. The county government aims to address the high capex associated with the LFG project by leveraging PPP opportunities. This approach involves collaborating with private sector entities to share the financial burden and risk of implementing the project. Through PPP arrangements, the county can access private sector expertise, technology, and funding, reducing the financial strain on public resources.

Risk management for clean cookstoves and fuels

Table 89: Risk management for achieving universal access to modern clean cookstoves and fuels

Challenge	Causes	Mitigating Actions	Responsibility
Lack of concrete policy to accelerate access to modern cooking fuels or advanced cookstoves	Lack of momentum among national institutions to promote advanced cookstoves	Both National and County government to take access to modern cooking services and fuels by 2030 as a priority	Government
Difficulties in the expansion of the infrastructure for natural gas and LPG to serve customers in remote rural areas	Scattered settlement making the expansion capital intensive	Promotion of biogas as the main option for a modern cooking fuel Establish rural based refilling centres and introduce affordable packages	Government/ private
Financing for cookstoves industry	The channels for providing credit for the manufacture or purchase of advance stoves, and for marketing them widely, are underdeveloped.	Development of appropriate channels for extending credit for developing the cookstoves market	Government/ private
Lack of concrete policy to accelerate sustainable biomass management	Lack of momentum among national and county governments to promote sustainable biomass management	County government to prioritise sustainable biomass management by 2030	
Charcoal production sector is largely unregulated and therefore, informal with low efficiency in transforming biomass into charcoal	Lack of momentum among national and county government to promote sustainable charcoal production	County government prioritise sustainable charcoal production by 2018	

Chapter 4: ENERGY EFFICIENCY AND CONSERVATION

4.1 Introduction

This chapter is to guide Kilifi County in contributing towards achieving the nationally established Energy Efficiency (EE) goals (G.o.K, Ministry of Energy and Petroleum, December 2015), which include:

- a) Reducing the national energy intensity by 2.8% per year; and
- b) Enabling the country to achieve a 32 percent emission reduction by 2030 relative to Business as Usual (143 MtCO₂e) and meet its national targets for SDG 7 by 2030.

County governments are responsible for supporting the implementation of national policies and regulations at the county level. At the national level, matters of energy efficiency and conservation are under EPRA. There are various national policies and regulations that govern the energy efficiency and conservation sector. The various laws and regulations provide guidelines on how the county governments will support the national government in implementing the national goals and objectives on energy efficiency and conservation.

4.2 Policies and Regulations that Relate to Clean Cooking

1. The Energy Act 2019 (Roles of County Government in Energy Efficiency and Conservation)

The Energy Act 2019 provides overall guidelines on the roles that county governments are required to perform to implement energy efficiency and conservation within their counties. Part VIII of the Energy Act 2019, Articles 193, 194, 195, 196, and 199 empower county governments to implement various activities under energy efficiency and conservation as discussed below;

- I. Power of County Governments to ensure efficient use of energy and its conservation. Under this article the A County Government may:
 - a) with the approval of the Authority, amend the energy conservation building codes to suit local climatic conditions and may, by rules made by it, specify and notify energy efficiency and conservation building codes with respect to the use of energy in the buildings;
 - b) direct every owner or occupier of a building or building complex being a designated consumer to comply with the provisions of the energy efficiency and conservation building codes;
 - c) direct, if considered necessary for efficient use of energy and its conservation, any designated consumer referred to in paragraph (b) to have an energy audit conducted by an accredited energy auditor in such manner and at such intervals as may be specified by regulations;
 - d) take all measures necessary to create awareness and disseminate information for the efficient use of energy and its conservation;
 - e) train personnel and specialists in the techniques for efficient use of energy and its conservation;



- f) take steps to encourage preferential treatment for the use of energy-efficient equipment or appliances;
 - g) direct any designated consumer to furnish to the Authority, in such form and manner and within such period as may be specified by rules made by it, information regarding the energy consumed by such consumer; and
 - h) specify the matters to be included for the purposes of inspection.
- II. Establishment of a Fund by County Government. Under this article:
- a) A county government shall establish a fund for the purposes of promoting efficient use of energy and its conservation within the county.
 - b) To the Fund shall be credited all grants and loans that may be made by the county government, national government, or any other organization or individual for the purposes of this Act.
 - c) The Fund shall be applied to meet the expenses incurred in implementing the roles assigned to the county governments by the Energy Act 2019.
 - d) The Fund created under sub-section (1) shall be administered by such persons or such authority and in such manner as may be specified in the rules made by the county government.
- III. Power of Inspection.
- a) The county government may appoint as many inspecting officers as may be necessary for the purpose of ensuring compliance with the minimum energy efficiency performance standards specified under section 190 or ensuring the display of particulars on the label of equipment or appliances specified under section 190 or for the purpose of performing such other functions as may be assigned to them.
 - b) Subject to any rules made under this Act, an inspecting officer shall have the power to—
 - i. inspect any operation carried on or in connection with the equipment or appliances specified under section 190 or in respect of which energy standards under section 190 have been specified;
 - ii. enter any place occupied by the designated consumer at which energy is used for any activity and may require any proprietor, employee, director, manager, secretary, or any other person therein to grant access:
 - to afford the inspector the necessary facility to inspect—
 - » any equipment or appliance as the inspector may require and which may be available at such place;
 - » any production process to ascertain the energy consumption norms and standards;
 - to make an inventory of stock of any equipment or appliance checked or verified by the inspector; or
 - to record the statement of any person which may be useful for, or relevant to, the efficient use of energy and its conservation under this Act.
 - c) An inspecting officer acting under this section shall, on no account, remove or cause to be removed from the place wherein he has entered, any equipment or appliance or books of accounts or other documents.



IV. Power of County Government to Issue Directions. Under this article;

- a) The county government may, in the exercise of its powers and performance of its functions under this Act and for the efficient use of energy and its conservation, issue such directions in writing as it deems fit for the purposes of this Act to any person, officer, authority, or any designated consumer, and such person, officer, authority, or designated consumer shall be bound to comply with such directions.
- b) For the avoidance of doubt, the power to issue directions under this section includes the power to enforce—
 - i. regulations of norms for process and energy consumption standards in any industry or building or building complex; or
 - ii. regulations of the energy consumption standards for equipment and appliances.

V. Power of County Government to Make Rules.

- a) A county government may, by notification, make rules for carrying out the provisions of this Act and not inconsistent with the rules and regulations, if any, made by the national government.
- b) In particular, and without prejudice to the generality of the foregoing, such rules may provide for all or any of the following matters—
 - i. energy efficiency and conservation building codes;
 - ii. the form, manner, and period within which information regarding energy consumption shall be furnished;
 - iii. the person or any authority who shall administer the Fund and the manner in which the Fund shall be administered;
 - iv. the matters to be included for the purpose of inspection;
 - v. any other matter which is to be, or may be, prescribed, or in respect of which provision is to be made, or may be made, by rules.

Kilifi County Government's energy efficiency and conservation in buildings, industrial processes, agriculture, and the transport sector as per the Energy Act 2019.

2. (Improved Biomass Cookstoves) Regulations of 2013

In reference to the Sessional Paper 4 of 2004 and the Energy Act of 2006, the Energy (Improved Biomass Cookstoves) Regulations of 2013 are intended for manufacturers, importers, distributors, technicians, and contractors of improved biomass cookstoves, and institutions using biomass fuels for cooking and heating purposes. Institutions that rely on biomass for cooking are required to install improved biomass cookstoves and maintain records of the stoves installed on their premises. The regulations also set out the various classes and requirements for licensing for installation, maintenance, manufacture, importation, and distribution of cookstoves for both household and institutional use.



3. The Climate Change Act 2016

This document is the national legislation that sets a response framework to climate change and provides mechanisms and measures to achieve low-carbon and climate-resilient development. Regarding energy efficiency, it requires the adoption of a NCCAP. The Action Plan shall aim to enhance energy conservation and efficiency and the use of renewable energy among end-users, industrial, commercial, transport, and domestic users and put in place measures for climate change mitigation.

4. National Climate Change Action Plan (NCCAP) 2023–2027

This is the third five-year plan that presents the detailed priority actions that Kenya will embark on to address climate change in the medium-term planning period and contribute to the achievement of our Nationally Determined Contributions (NDC) under the Paris Agreement. It identifies six priority mitigation sectors; the energy sector is one of them. These sectors are expected to reduce their GHG emissions so that Kenya can meet its Nationally Determined Contribution goal of reducing its GHG emissions by 32 percent by 2030, from the business-as-usual scenario of 143 MtCO₂eq. Improvement of energy efficiency and conservation is identified as one of the key action areas. In the energy sector, the priority action areas will be:

Manufacturing: Improve energy and resource efficiency in the manufacturing sector.

- Enhance energy efficiency.
- Promote resource use efficiency and circular economy in industrial processes.
- Promote green building design and construction

Energy and Transport

- **Energy:** Ensure an electricity supply mix based mainly on renewable energy, an electricity system that is resilient to climate change and promotes energy efficiency, and encourage transition to clean cooking. This will involve:
 - Promote clean, affordable, and quality alternative renewable energy sources.
 - Enhance electricity network expansion and improvement, as well as electricity access in grid and non-grid areas.
 - Promote clean cooking fuels and technologies.
 - Promote geothermal energy for alternative (direct) uses.
 - Climate-proof energy infrastructure.
- **Transport:** Establish efficient, sustainable, world-class transport systems and logistics systems that withstand the projected impacts of climate change. This will involve:
 - Reduce traffic idling.
 - Develop efficient public transport operations, including Bus Rapid Transit in Nairobi.
 - Develop and improve non-motorized transport facilities.



5. The Energy (Appliances' Energy Performance and Labelling) Regulations 2016.

The regulations require that specified appliances manufactured or imported in Kenya shall be tested for energy performance in an accredited laboratory, registered with the EPRA, and affixed with the appropriate energy star label.

6. Energy (Energy Management) Regulations 2012

This document requires that all commercial buildings and industrial and institutional facilities whose energy consumption exceeds 180,000 kWh per year should develop an energy management plan, carry out energy audits at least once every three years, and implement at least 50 percent of the energy savings recommendations within three years.

7. Energy Management Standards 2018

The Kenya Bureau of Standards is developing energy management standards to cover energy management systems, energy auditing, and energy efficiency performance measurement and verifications.

8. Energy Management Standards Green Economy Strategy and Implementation Plan (GESIP), 2018.

The GESIP is a blueprint for enhancing low-carbon, resource-efficient, equitable, and inclusive socio-economic transformation. Furthermore, it focuses on eliminating the socio-economic constraints to attaining Kenya Vision 2030 and is aligned with the outcomes of the United Nations Conference on Sustainable Development (Rio+20). The plan is to facilitate Kenya's transition to a sustainable path through five thematic areas and strategies, which are promoting sustainable infrastructure, building resilience, sustainable natural resource management, promoting resource efficiency, social inclusion, and sustainable livelihoods. The GESIP aims at guiding national and county governments and other stakeholders on the transition to sustainable development pathways to realize Kenya Vision 2030 and calls for a greater focus on green growth, a cleaner environment, and higher productivity. The objectives for increasing national energy efficiency include:

- Develop sector-specific energy efficiency targets and benchmarks,
- Roll out demand-side energy efficiency programmes in buildings and facilities.
- Roll out supply-side energy efficiency programmes through system reinforcement, efficient transformers, and grid extension projects.
- Adopt Minimum Energy Performance Standards (MEPS) for lighting and industrial products,
- Develop technical and infrastructural capacity for energy audits, equipment testing, and certification.
- Review national and county policies to respond to new technology and innovation.
- Enhance the application of voluntary management approaches to energy efficiency, clean and renewable energy



9. Performance Standards for Cooking Stoves 2019

New Performance Standards for cookstoves have been gazetted. CCAK is developing a voluntary star labelling scheme for cookstoves on sale based on these standards.

4.3 Past and current initiatives on Energy Efficiency and Conservation

1. Removal of Barriers to Energy Conservation and Energy Efficiency in Small and Medium-sized Enterprises (SMEs)¹⁴.

The Global Environmental Facility–Kenya Association of Manufacturers (GEF-KAM) funded project. The international development partners who provided support under this project consisted of the UNDP, the Global Environment Facility (GEF), and the United Nations Office for Project Services (UNOPS). The project started in 2001 and ended in 2006. It ran under the Ministry of Industry and Trade. Its final project report revealed that the potential for energy efficiency improvement in industrial SMEs ranged from 10 to 30 per cent. The low efficiency was due to lack of information, motivation and expertise, and the existence of financial constraints in adopting emerging energy efficiency and conservation technologies and innovations¹⁴.

2. Centre for Energy Efficiency and Conservation (CEEC)

The CEEC was the successor to the GEF-KAM Energy Efficiency Project. Key activities of the CEEC included undertaking energy audits on behalf of the MoEP in mainstream industries, SMEs, and public institutions, provision of capacity-building in energy efficiency and conservation, public education and awareness activities as well as administration of the Energy Management Awards (EMA) annual event. From the CEEC initiatives, more than KES 13 billion (USD 152.8 Million) of energy cost saving has been realized, equivalent to 2014.8 GWh. These energy savings translate into a deferment of deferring a 230-MW power plant.

KPLC has also undertaken Demand Side Management activities to improve energy efficiency. Key activities included Compact Fluorescent Lamps (CFLs) roll-out in the residential sector. Over four million energy-saving bulbs were distributed in two phases, resulting in substantial energy and monetary savings for consumers. In Phase 1 (2010), 1.25 million CFL bulbs were distributed, while in Phase 2, 3 million were distributed to KPLC customers. The demand savings were equivalent to 50 MW and 105 MW, respectively.

4.4 Status of Energy efficiency and Conservation

4.4.1 Buildings

In the context of this energy plan, buildings collectively refer to residential, learning, and health facilities, public and commercial buildings. The energy in buildings is used for space heating, cooling, ventilating,

¹⁴ Final Evaluation of the UNDP-GEF Project. <https://eartheval.org/sites/ceval/files/evaluations/125%20Removal%20of%20Barriers%20to%20Energy%20Efficiency%20and%20Conservation%20in%20Small%20and%20Medium%20Enterprises%20in%20Kenya.pdf>



lighting, cooking, water heating, refrigerating, and operating electric and mechanical devices. Energy efficiency measures in the buildings sector can deliver some of the greatest energy savings through 2030 and beyond. Buildings represent about 30% of the global final energy consumption (Alliance for an Energy Efficient Economy (AEEE) and SEforALL in Collaboration with IEA., March 2023). The sector's 3 Gt CO₂ emissions accounted for 15% of total emissions from end-use sectors in 2021, but this share doubles if indirect emissions from electricity and heat production are included. Despite a gradual shift away from fossil fuels, direct emissions from the buildings sector have risen by 0.5% per year since 2010, driven by rising demand for energy services (International Energy Agency, November 2022).

According to Kenya Power, buildings, commercial/industrial, and street lighting consumed 45%, 54%, and 1% of the electricity generated in the 2022/23 financial year (Kenya Power, June 2023). County energy use in buildings is expected to grow as the county continues to modernize and per capita income levels continue to increase. Because of their high energy consumption, residential, public, and commercial buildings also offer unparalleled opportunities for energy savings. According to the IEA, buildings account for 41% of global energy savings potential by 2035, compared with the industrial sector (24%) and the transport sector (21%).

Unsustainable utilisation of biomass as a primary source of energy has stressed the urgent need to shift to alternative sources of energy as well as efficient end-use technologies. The technologies include the household's improved firewood and charcoal stove with have thermal efficiency of 1%–37% and 27%–47% respectively. The household's liquid fuels (kerosene and bioethanol) achieved a much higher thermal efficiency of 30%–53%, while the thermal efficiency of institutional cookstoves ranged between 43% to 65% (GoK, Ministry of Energy and United Nations Development Programme, September 2014). The fireless cookers that can save up to 50%, and improved charcoal kilns can save up to 60% of energy when compared to traditional technologies" (Mugo, F. and Gathui, T. of Practical Action, October 2010).

4.4.1.1 Analysis of Energy Consumption for Heating and Cooking Consumption

The following are the statistics of households' access to various types of cooking fuels in Kilifi County; 11.1%—LPG, 0.7%—electricity, 7.4%—paraffin, 58.2%—firewood, and 21.9%—charcoal (Kilifi County Govt and GROOTS Kenya, December 2019). The population of Kilifi County stands at 1,453,787 (Kenya National Bureau of Statistics, 2019). The access percentage is used to calculate the population using a certain type of cooking fuel. It is assumed that this population use exclusively a given cooking fuel. The amount of fuel consumed in 2019 is indicated in Table 90 and 91.

Table 90: The Amount of Fuels Consumed in Heating and Cooking at HHs and Institutions in 2019

Type of Fuel	Population Consuming the fuel	Fuel Consumption per capita per day	Amount of Fuel Consumed in 2019
Firewood	58.2 % x 1,453,787 = 846,104	1.75 kg (Kituyi & al, 2001)	540,448,930 kg
Charcoal	21.9 % x 1,453,787 = 318,379.4	0.435 kg (Kituyi & al, 2001)	50,550,689 kg
LPG	11.1 % x 1,453,787 = 161,370.4	0.007 kg (Kituyi & al, 2001)	412,301 kg
Kerosene	7.4 % x 1,453,787 = 107,580.2	0.06 l (Kituyi & al, 2001)	2,356,006 litres



Table 91: Amount of Energy Consumed in Heating and Cooking at HHs and Institutions in 2019.

Type of Fuel	Amount of Fuel Consumed In 2019	Energy Consumed in MJ	% Amount of Energy Consumed
Firewood	540,448,930 kg	8,647,182,880	84.41
Charcoal	50,550,689 kg	1,299,152,707.3	14.56
Sub-total (Renewable Energy)		9,758,553,090	98.97
Liquefied Petroleum Gas (LPG)	412,301 kg	19,007,076.1	0.00002
Kerosene	2,356,006 litres	83,025,651.44	0.83
Sub-totals (Fossil Fuels)		102,032,727.54	1.01
Total		9,860,479,797.3	100.00

N/B

Energy caloric values used in the calculations are Firewood 16 MJ/kg, Charcoal 25.7 MJ/kg, LPG = 46.1 MJ/kg, and Kerosene = 35.24 MJ/litre.

Based on the report ‘Kenya Household Cooking Sector Study’ (2018) a first assessment at national level has been done. The average values of intrinsic energy needs are respectively:

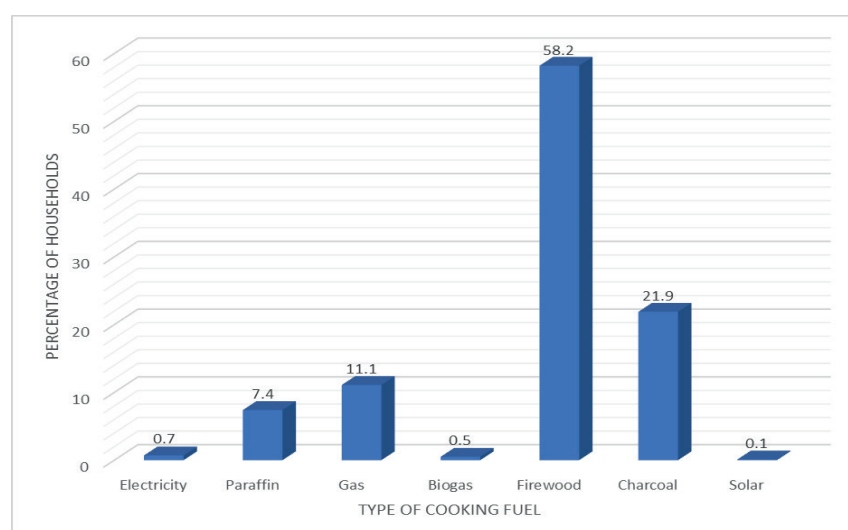
- 3.9 GJ/per person/year for an average urban consumer and
- 2.5 GJ/per person/year in the rural areas.

4.4.1.2 Energy for Cooking in Building

1. Energy for Cooking in Households

Figure 55 show the percentages of households using different types of fuels for cooking at the County level. Woodfuel is the main source, standing at 80.1%, followed by Gas at 11.1%, and Paraffin at 7.4% (Government of Kenya, KNBS Census, 2019) in the County.

Figure 55: % Distribution of HHs by Cooking Fuel Source in Kilifi



Source: KNBS Census 2019

In Kilifi County, households using the following cookstoves—three-stone, traditional metal jiko, energy-saving jiko, paraffin cookstoves, LPG cookstoves, and electric cookers—were 58.1%, 6.5%, 19.2%, 5%, 10.7%, and 0.5%, respectively (Kilifi County Government and GROOTS Kenya, December 2019). The percentage of households using inefficient cookstoves in rural areas was very high, standing at 89.3%, with three-stone accounting for 87.7% and traditional metal jiko at 1.6% (Kilifi County Govt and GROOTS Kenya, December 2019). Table 92 shows the percentage of households' primary cookstove.

Table 92: The Percentage of Households' Primary Cookstove in Kilifi County

Households' Category	Three stone Cookstove %	Ordinary Metallic Jiko Cookstove %	Ceramic Cookstove %	Paraffin Cookstove %	LPG Cookstove %	Electric Cookstove %	Biogas Cookstove %
Rural	87.7	1.6	9.7	1	0.1	0	0.5
Peri-urban	67.3	16	6	11.3	7.3	0.7	0
Urban	19.3	2	42	1.1	24.7	0.7	0
Average access	58.1	6.5	19.2	4.5	11	0.5	0.2

Source: Kilifi County Govt and GROOTS Kenya, December 2019

2. Energy for Cooking in Learning Institutions

- There are 926 ECDCs, of which 548 are public, and 547 are public primary schools in the County. According to the County Directorate of Education, all these public ECDEs and primary schools use exclusively firewood in three-stone open fires for cooking in temporary kitchens.
- According to the County Directorate of Education, there are a total of 165 secondary schools in the county. All these schools use firewood as the primary source of fuel for cooking. Out of the 165 schools, 101 are cooking with unimproved stoves (type unspecified) in temporary kitchens, while 64 are cooking with improved institutional stoves in permanent kitchens.
- As per the County Government's Department in charge of VTCs, there are a total of 53 Technical and Vocational Education and Training institutions (TVETs) in the county. All these institutions are cooking with firewood and charcoal as primary and secondary fuels, respectively, in temporary kitchens. The type of stoves used is not provided. For institutions whose enrollment data was available, the average enrollment per institution is 164.

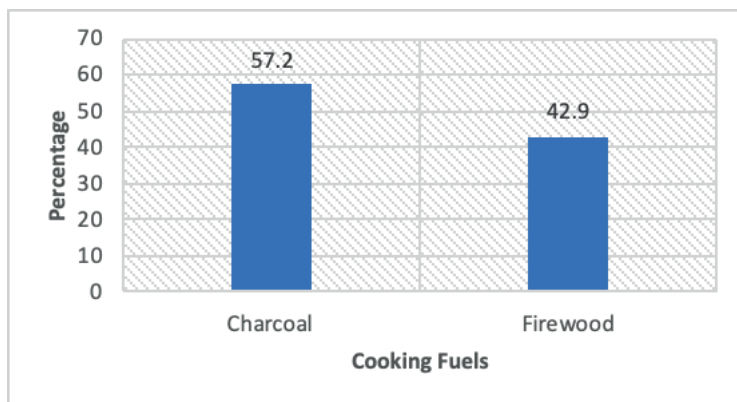
3. Energy for Cooking in Public and Commercial Buildings

From the hospitality industry, 7 food kiosks/vibandas, 10 restaurants, and 3- and 4-star hotels were sampled to provide insights into the cooking solutions used in this industry.



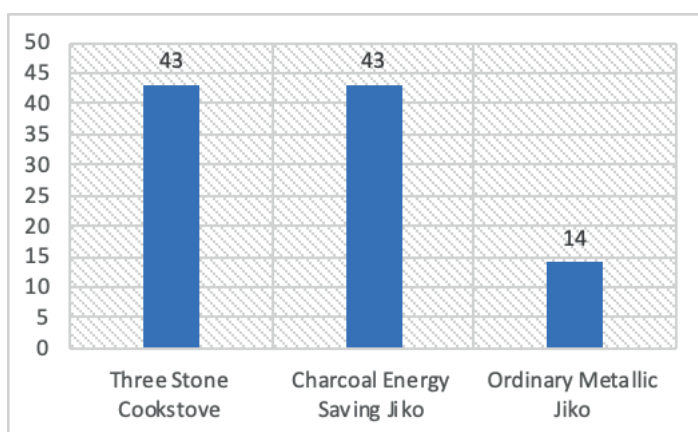
Food Kiosks/Vibanda Eateries

Figure 56: Primary Cooking Fuels in Food Kiosks/Vibanda Eateries



Source (Kilifi County—SETA Team, August 2023)

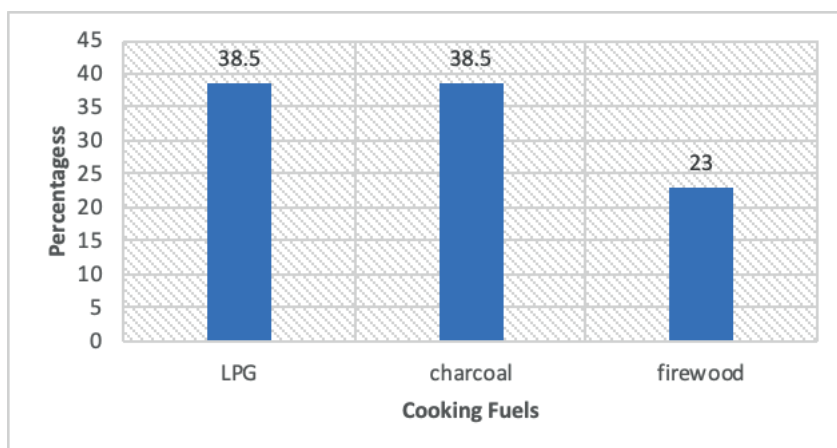
Figure 57: Cooking Technologies used in Food Kiosks/Vibanda Eateries



Source (Kilifi County—SETA Team, August 2023)

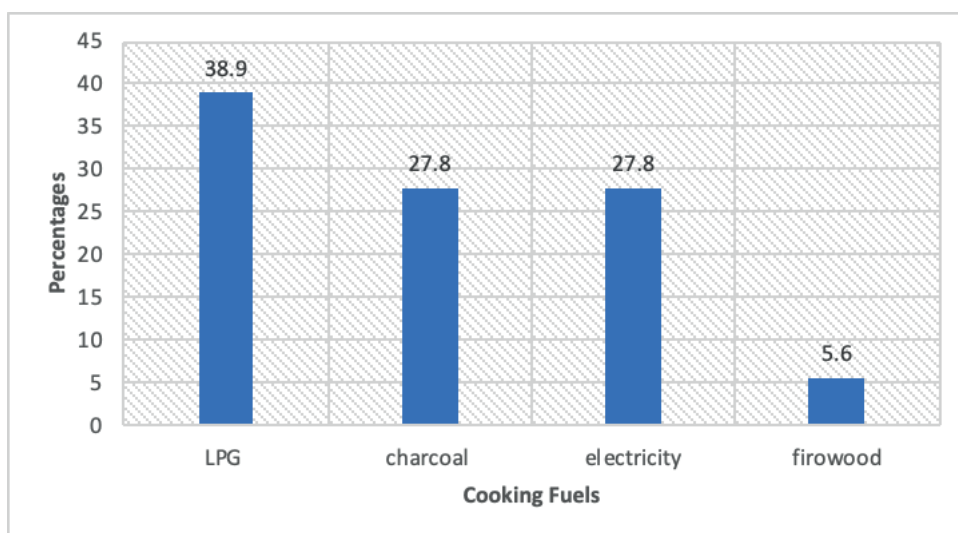
Restaurants

Figure 58: Primary Cooking Fuels in Restaurants



Source (Kilifi County—SETA Team, August 2023)

Figure 59: Secondary Cooking Fuels Used in Restaurants



Source (Kilifi County—SETA Team, March 2023)

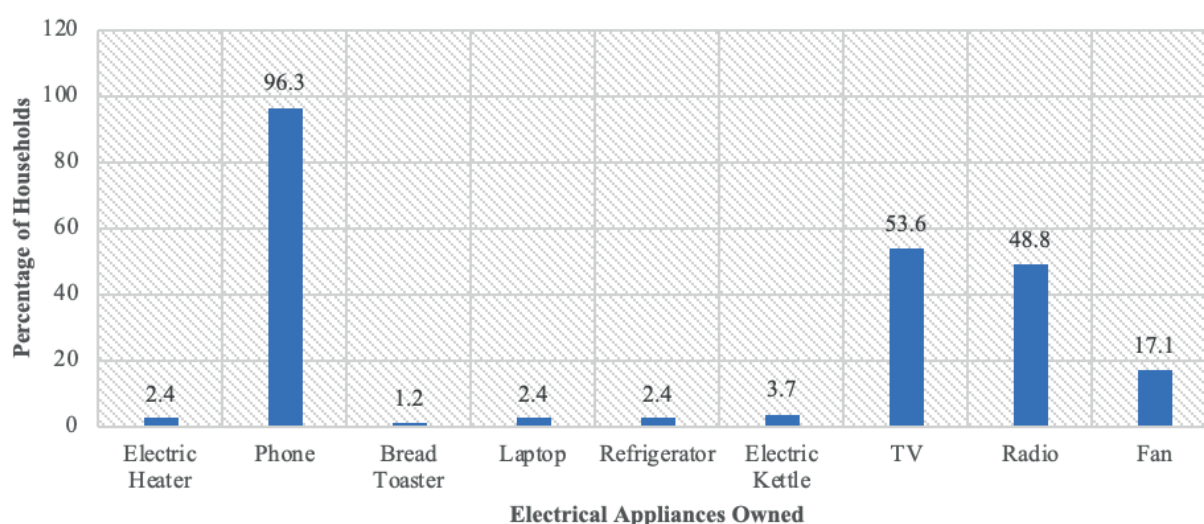


4.4.1.3 Energy Access to Lighting in Buildings

1. For Households

- The use of electricity in Kilifi County is highest, standing at 58.5%, with grid electricity contributing 38.5% and standalone solar PV systems at 20% (Government of Kenya, KNBS Census, 2019). The use of paraffin for lighting is second highest, standing at 33.4%, with the use of tin lamps, lanterns, and pressure lamps contributing 26.7%, 6.1%, and 0.6%, respectively. Therefore, the population of Kilifi County with no access to electricity stands at 41.5% (Government of Kenya, KNBS Census, 2019).
- From the SETA survey on energy usage at the household level, apart from lighting, households own various electrical appliances as indicated in Figure 60.

Figure 60: Electrical Appliances Owned by Households



Source: (Kilifi County—SETA Team, March 2023)

2. For Learning and Health Institutions:

- Level 2 health facilities owned various office machines, including printers, computers, laboratory machines/equipment, heaters, and fans; level 3 facilities had office machines/equipment, air conditioning systems, washing machines, fridges, laboratory equipment, and machines. Level 4 facilities owned various medical equipment (x-rays, ultrasound machines, oxygen generators, fridges, air conditioners, incubators, ICU/HDU machines, autoclaves, anesthetic machines, suction machines, compressors, and freezers). These appliances consume a lot of energy. For instance, it was noted that Bamba and Mtwapa Sub-county Hospitals spend KES 100,000 each per month on electricity bills.
- Primary day schools with about 2,360 students spend KES 9,000–20,000 per month on electricity bills, depending on the number of electrical appliances they own (computers, internet, fans, printers, photocopiers, bulbs). A boarding secondary school with a population of 800–1,200 spends between KES 80,000 and KES 100,000 per month, while a day secondary school with about 600 students spends KES 30,000.

- Technical colleges, such as Godoma Technical with 1,200 day scholars, spend KES 500,000 per month, while Weru Technical, with 200 boarders and 700 day scholars, spends KES 300,000 per month on electricity bills.

3. Public and Commercial Buildings

Public and commercial buildings include those owned by the government, while commercial buildings include those owned by the private sector and the hospitality industry. These buildings are used to run various government businesses and commercial activities.

i. Hospitality Industry

Energy for cooking and heating water is a significant expense in the hospitality industry. According to a sample survey carried out by the SETA team, the amount spent on electricity by hospitality businesses varies. Food kiosks/vibandas spend between KES 1,500 and KES 9,000; restaurants spend KES 10,000 to KES 100,000; and 3–4 star hotels spend between KES 40,000 and KES 700,000, depending on the electrical appliances owned by the facility and their usage. Three- to four-star hotels typically own appliances such as fridges, freezers, cold rooms, air conditioners, fans, ovens, irons, heaters, blenders, washing machines, pumps, computers, and electric cookers, which consume a significant amount of electricity.

ii. Public and Other Commercial Buildings

Energy consumption in these buildings is used for space cooling, ventilation, lighting, and the operation of electric and mechanical devices. These buildings include offices and retail shops.

4.4.2 Industrial Processes and Agriculture

In the context of this plan, industry refers to all activities involved in manufacturing/processing products or the provision of particular services, while agriculture refers to all activities involved in crop and animal production. Industrial efficiency is a crucial pillar of the county's energy efficiency policy and is an integral part of several counties' flagship initiatives on energy efficiency. Kilifi County has both large well-established industries as well as many SMEs. These SMEs are engines of growth, vital to most economies.

Kilifi County has 25 major industries (Kilifi County Government, 2018) and an unknown number of SMEs. Twenty of these companies were identified and requested to provide data on their energy consumption for both process heating and electricity. Fourteen of them provided their data. From the analysis, the consumption of fossil fuels (coal, fuel oil, diesel, and kerosene) in 2019 was 8,184,940 GJ, with coal, fuel oil, diesel, and kerosene contributing 67.5%, 30.2%, 0.05%, and 2.3%, respectively. The consumption of renewable energy was 44,750 GJ, with cashew nut husks and briquettes contributing 1.92% and 98.08%, respectively. The amount of renewable energy consumed in industries in Kilifi County in 2019 was only 0.54%. Coal is used exclusively in cement factories and contributed 93.82% of the energy consumed in industries in 2019. Therefore, considerable effort is needed to increase the use of renewable energy from 0.76% to at least 80% by 2030. The situation is more complicated given that the county's forest cover is 7.67% (KIARIE. N, 2016), which is below the minimum target of 10% set by the national government. Additionally, the county lacks data on the energy consumption of the industrial and agricultural sectors to set appropriate energy efficiency targets.

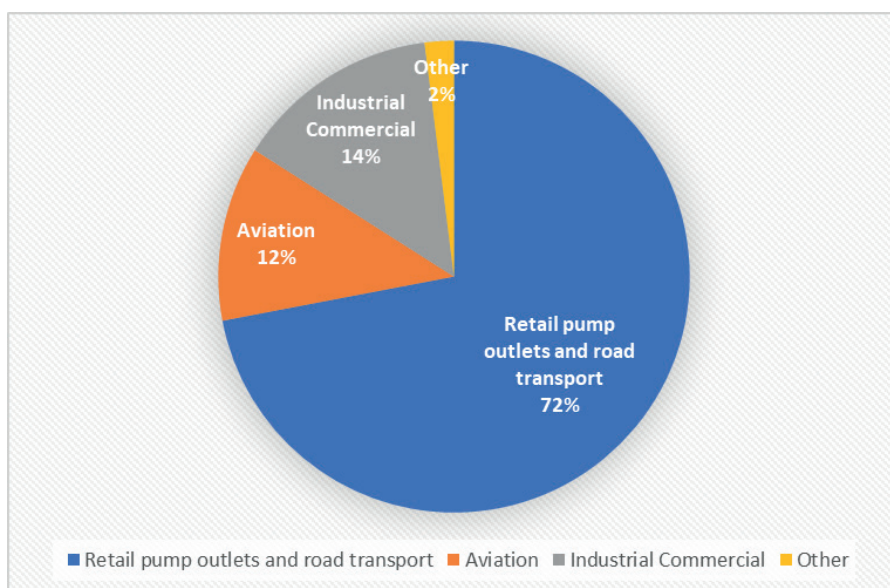


Industrial energy efficiency is of great importance for expanding energy access, improving business competitiveness, and enhancing energy security. Agriculture contributed 34.1% to Kenya's GDP in 2019 and remains a key economic sector. With increasing utilisation of solar energy in Kenya, productive use of energy for agricultural activities is rising, helping to reduce energy consumption and operating costs. Some challenges exist in the agricultural sector, such as irrigation, processing, and supply chain wastage. These challenges have informed the development of most off-grid solar systems for productive use, including solar water pumping and cold storage.

Transport

The transport sector consumes about 72% of all the petroleum products imported into Kenya (figure 61).

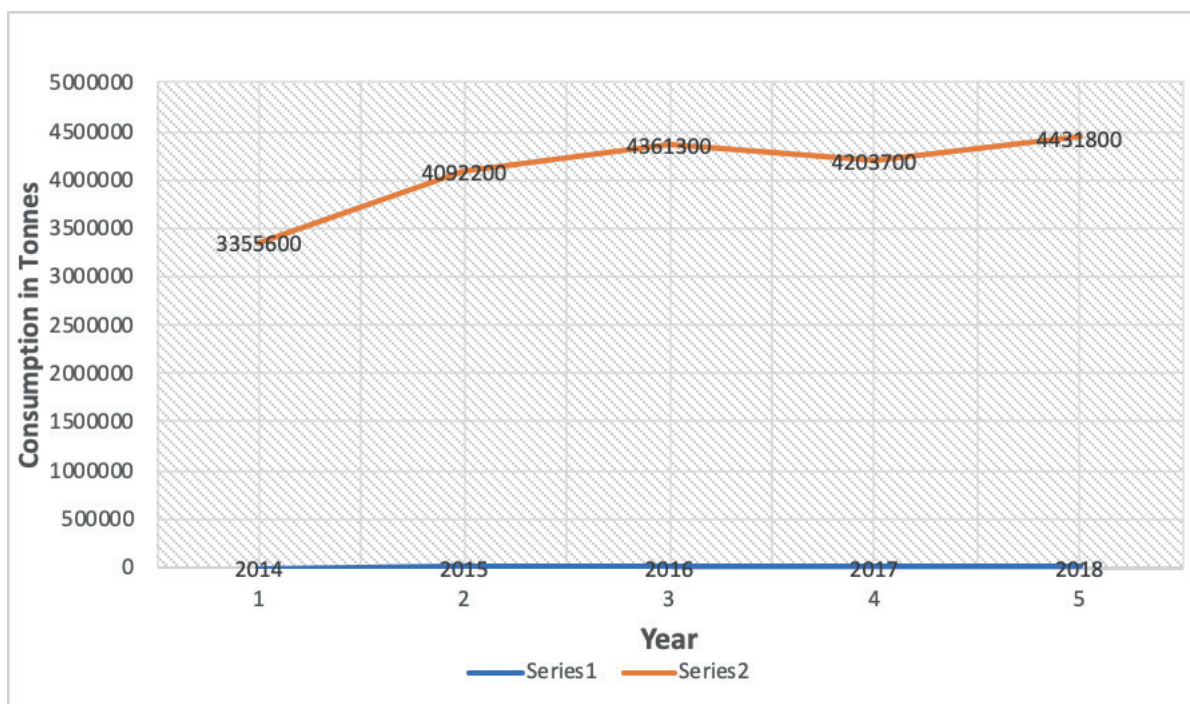
Figure 61: Petroleum Fuel Consumption by Sector in Kenya, 2019



Source: KNBS, Economic Survey, 2019

- Road transport accounts for 84.5% of petroleum fuel demand, followed by air transport at 15.1%.
- Air transport: The total number of passengers handled increased by 16.8%, from 10.1 million in 2017 to 11.8 million in 2018. The volume of commercial cargo traffic handled increased by 23.3%, from 290.8 thousand tonnes in 2017 to 358.7 thousand tonnes in 2018. Figure 61 shows an upward trend in petroleum fuel consumption in the transport sector from 2014 to 2018.

Figure 62: Trends in Fuel Consumption



Source: KNBS, Economic Survey, 2019

- Kenya currently has about two million vehicles, of which about 98% use petrol and diesel.
- In 2018, a total of 102,036 motor vehicles and 195,253 motorcycles (and tuk-tuks) were registered. This means that the **average monthly registration is about 8,500 motor vehicles and 16,270 motorcycles**.
- It is estimated that 30% of all vehicles operating in Kenya are more than 15 years old. As vehicles age, their efficiency declines, and their operating cost increases¹⁵.
- **There is a challenge in regulating the transport sector, contributing to disorder on the roads and energy inefficiencies.**
- Kenya is developing inclusive vehicle emission **regulations aimed at reducing emissions** in the country. These regulations are expected to improve air quality by allowing the government to outsource vehicle emission tests to the private sector.
- The latest EPRA data shows that energy consumption by the e-mobility sector increased from 29,097 kWh in July to 75,729 kWh in December. Energy consumption by electric vehicles and bikes increased by a record **160%** in the six months to December 2023, reflecting increased use of e-transport. The data also indicates that continued adoption of e-mobility is anticipated to elevate energy demand, particularly during off-peak periods, historically characterized by low demand.
- To encourage the adoption of electric vehicles, the regulator implemented a special tariff **for e-mobility**, effective 1st April last year.

¹⁵ 27 <http://www.kmi.co.ke/kmi-briefs/vehicle-ages> /<https://t2m.org/exploring-public-road-passenger-transport-in-kenya/>



- Further, the regulator released guidelines for electric **vehicle charging and battery swapping** infrastructure in September. These guidelines provide a summary of essential considerations for setting up, designing, installing, and operating electric vehicle charging points and stations.
- During the review period, 2,694 electric vehicles (EVs) were registered, bringing the cumulative number of registered EVs to **3,753**.
- EPRA attributes this increase to government initiatives, such as the introduction of the e-mobility tariff, a reduction of excise duty on EVs from 20% to 10%, and the exemption of fully electric cars from Value Added Tax (VAT).
- As of December 2023, EVs **constituted 1.62%** of vehicles registered that year, with the country aiming to reach 5% by 2025.
- The role of county governments in transport administration covers local roads, street lighting, traffic control, and parking. County governments also support the national government in implementing energy efficiency measures at the county level, including public road transport.

4.5 Pathways for Increasing Energy Efficiency and Conservation

4.5.1 Buildings

4.5.1.1 Improve the energy efficiency of cooking and heating appliances

The pathways for improving energy efficiency of cooking appliances, Kilifi County Government will mobilize financial resources and support the use of highly efficient cooking technologies and adoption of clean cooking solutions in households. The funds collected will be used to:

- Support the production of energy-efficient charcoal and fuel-wood stoves, thus increasing the uptake of efficient cookstoves and creating employment opportunities in urban and rural areas. There is sizeable potential to improve the efficiency of stoves: energy-efficient charcoal equipment for cooking can achieve a thermal efficiency of 30–40%, compared with 10–20% for most traditional cookstoves. Shifting to efficient stoves for both woodfuel and charcoal burning in Kilifi could cut biomass consumption for cooking by 60% by 2040 and reduce charcoal consumption by 35%. These gains are instrumental in reducing wood demand for charcoal production in the county.
- Support the installation of LPG systems, particularly in public institutions.
- Support the installation of biogas plants to produce gas for cooking.
- There is considerable potential to reduce upstream efficiency losses in charcoal production: conventional production practices rely on earth-mound kilns that operate at 8–20% efficiency, but more efficient kilns can reach 35–40%.

4.5.1.2 Improve the Energy Efficiency of Electrical Consumption

In Kilifi County, a high percentage of energy is consumed in residential houses, learning institutions, levels 4 and 5 health facilities, and the hospitality industry, where it is used for space cooling, ventilation, lighting, cooking, water heating, refrigeration, and operating electric and mechanical devices. The county government will implement the following to achieve energy efficiency improvements for electrical appliances:

1. Develop or strengthen building energy codes to ensure all buildings are built to optimal energy efficiency levels, aiming for a 40% improvement.



2. Promote integrated approaches combining passive building design and affordable energy-efficient technologies to accelerate access to thermal comfort for all.
3. Implement appropriate MEPS for all appliances, aiming for a 25% decrease in total energy use by 2030. By 2030, all new lighting could be based on LED technology, and by 2035, most air conditioners sold could be best-in-class, reducing energy demand by more than 25%.
4. Implement minimum energy performance standards for buildings.
5. Promote new green public buildings.
6. Integrate renewable energy technologies in buildings to reduce energy consumption and the carbon footprint. Solar water heaters, small wind turbines, and solar PV electricity generation are examples of technologies that can reduce operational energy consumption.
7. The County Government will systematically improve energy efficiency in public buildings by:
 - a) Conducting a rapid energy efficiency assessment of public buildings to identify key opportunities and challenges.
 - b) Implementing energy efficiency initiatives in public buildings—such as county offices, schools, and hospitals—to lead by example.

4.5.2 Industrial Processes and Agriculture

- Implement policies supporting or mandating energy or emissions audits and reporting in industries using consistent, accurate, and reliable methods.
- Support energy management systems.
- Promote high-efficiency industrial equipment, such as heat pumps and other electrification technologies for low and medium-temperature process heat, as well as LED lighting.
- Implement policies for heavy industries to drive higher energy and material efficiency and increase the use of low-carbon alternatives.
- Energy Audits and Benchmarking
 - » Conduct regular energy audits to identify areas for improvement.
 - » Benchmark energy performance against industry standards.
- SMEs perceive the most popular standard on Energy Management Systems (EnMS), i.e., ISO 50001 as expensive and onerous. The simplified ISO 50005, launched in 2021, is designed to overcome this problem and is aimed at the small and medium-sized business sectors. Kilifi County can use this or BS ISO 50005:2021 to promote EnMS as a viable means of reducing energy consumption and accelerating the uptake of systems approaches.

4.5.3 Transport Sector

1. Enhance public modes of transport

Adopt safe and energy-efficient urban transport to reduce emissions.

Outputs:

- » A shift to public transport and non-motorized modes,



- » Complementary walking and cycling infrastructure developed with support from county governments,
- » Increased investments in rapid transit and non-motorized travel systems.

2. Communication for Energy Efficiency Programme

Creating an informed public that understands the rationale for energy efficiency and conservation improves the chances of achieving these objectives. There is a need for consumer behavioral change in energy consumption practices for these objectives to be realized.

- i. Develop a communication strategy for EE&C to:
 - a) Educate stakeholders on the business case for energy efficiency, addressing customer, utility, and societal perspectives.
 - b) Communicate the role of energy efficiency and conservation in lowering energy bills, system costs, and risks over time by promoting behavior change in households.
 - c) Highlight the importance of building codes, appliance standards, and other incentives.
 - d) Use media such as social media, radio, TV, newspaper advertisements, leaflets, billboards, direct mail, and newsletters to reach all stakeholders in the energy efficiency and conservation sector.
- ii. Build capacity among key stakeholders: Policymakers, academics, journalists, energy product companies, NGOs, citizens, CSOs, industry and trade associations, and private sector actors to increase awareness of energy efficiency and conservation.
- iii. Conduct a countywide baseline study on the adoption of EE technologies and their impacts. Cost-benefit analyses should prioritize impacts to help consumers understand the financial benefits of adopting EE technologies.
- iv. Establish a knowledge management framework for energy efficiency and conservation, including:
 - a) An energy efficiency and conservation resource center,
 - b) Enhanced data collection, collation, processing, analysis, and administration, of energy efficiency and conservation statistics,
 - c) An effective monitoring and reporting framework,
 - d) Database development, and
 - e) Development of educational materials targeting specific stakeholders.

4.5.4 Envisioned Progression to Energy Efficiency and Conservation

4.5.4.1 Progression in Adoption of Energy Efficiency and Conservation

Building Sector

Cooking and Heating Technologies

In Kilifi County, 58.1% of households use three-stone cookstoves, while 6.5% use ordinary metallic jikos (charcoal) (Census 2019, GROOTS Kenya). Learning institutions also use three-stone cookstoves, including 926 ECDEs, 559 primary schools, 101 of 165 secondary schools, and 53 VTCs. The hospitality industry shows a mix of cooking technologies, with high-end hotels using LPG and electricity, and lower-end hotels relying heavily on three-stone cookstoves.



Phasing out of inefficient three stone cookstoves and the ordinary metallic jiko in Households

Year		2019 (Census)	2022 (Projected)	2025 (Projected)	2027 (Projected)	2028 (Projected)
Projected Population		1,453,787	1,547,747	1,636,510	1,696,226	1772556.17
Metallic (ordinary) Charcoal Cookstoves %	%	6.5	6	4	0	0
	No	196868	19347	13638	0	
Three Stone Cookstoves %	%	58.1	55	30	15	0
	No	175969	177346.4	102282	53007.15	0
Total inefficient Cooking Devices %	%	64.6	61	34	15	0
	No	195656	196693.28	115919	53007	0

Source: Author

Phasing out of inefficient three stone cookstoves in learning Institutions

Year		2023	2024	2025	2026	2027	2028
No. of ECDEs		946	946	946	946	946	946
Three Stones Open Fire	%	100	100	90	65	50	0
	No	946	946	851	614	473	0
No. of Primary schools		559	559	559	559	559	559
Three Stones Open Fire	%	100	100	80	50	25	0
	No.	559	559	447	280	140	0
	No.	0	0	0	28	56	112
No. of Secondary schools		132	132	132	132	132	132
Three Stones Open Fire	%	76	70	50	25	10	0
	No.	101	92	66	33	13	0
No. of Tertiary institutions		53	53	53	53	53	53
Three Stones Open Fire	%	100	94	75	38	19	0
	No.	53	50	40	20	10	0

Source: Author

Phasing out of inefficient three stone cookstoves in Hospitality facilities

Year	2023	2024	2025	2026	2027	2028
Food Kiosks/Vibandas						
Three Stones Open Fire primary & Traditional Metallic Charcoal Stoves Secondary %	43	40	30	20	10	0
Restaurants						
Firewood Masonry jiko %	30	25	20	10	5	0

Source: Author



4.5.5 Estimated Investments for Energy Efficiency and Conservation Measures

Table 93: Capital Cost of Acquisition Clean Cooking Solution by Households

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES)
Building codes	Review of conservation building codes	12,000,00	1	12,000,000
Carry Energy consumption baseline studies	Carry out sample survey on energy consumptions in residential houses and institutions	2,000,000	3	6,000,000
Energy assessment in public buildings	Carrying out a rapid energy efficiency assessment of the public building sector that identifies key opportunities and challenges, assesses stakeholders and resources, and determines priorities and next steps;	2,000,000	8	16,000,000
Capacity building of Key stakeholders	These include policy-makers in national and county government, academics (universities, technical and vocational training institutions and research organizations), journalists, companies trading in energy products, Non-governmental Organizations, citizens, Civil Society Organizations, industry and trade associations and private sector actors to increase energy efficiency and conservation awareness.	2,000,000	10	20,000,000
Implementation of energy efficiency	Implementing energy efficiency initiatives in public buildings—such as county offices, schools, and hospitals—in order to lead by example;	2,000,000	50	100,000,000
Support installation of efficient kilns for charcoal production	Support charcoal producer association to install efficient kilns for charcoal production	2,000,000	10	20,000,000
Carry out energy audit	Carry out energy audit in public institutions	3,000,000	20	60,000,000
Installation of smart energy efficient street lighting system	Install smart street lighting on at least 5 streets	20,000,000	5	100,000,000
Total				334,000,000

4.5.6 Risk and mitigation

Table 94: Risk management in achieving the energy efficiency targets

Risks	Impact	Mitigation	Responsibility
Exchange rate risks related to the projects, especially for equipment sold in international markets	Avoidance of buying efficient equipment	Local manufacture of energy efficient equipment	Government
Regulatory, governance and contract uncertainties with equipment suppliers, contractors and third parties who may be necessary to implement projects;	Lack of confidence in the organisations Management to issue contract to Energy Service Companies	Strengthen the regulatory and governance of contracts	MoEP
Limited access to capital/credit, which often implies a very short-term payback approach to EE project evaluation especially for small micro enterprises	Inability to pay for energy efficient technologies	Increasing the credit tenor Creation of a fund to support energy efficiency projects	Financial Institutions, CSOs, Development partners
The mismatch of investment costs and energy savings costs, budget and credit constraints and the opportunity costs of exhausting one's credit limits on energy efficiency rather than on increasing sales;	No budget set aside for investing in energy efficient projects	Inclusion of budget of implementation of energy efficient projects in the investment plan	Government
Availability of energy is a critical issue: Even when manufacturing firms are willing to assume a high unit cost per kWh, energy supply is often not only insufficient, but also unreliable, giving rise to costly backup and self-generation (e.g. smelting and energy dependent, continuous chemical processes) in many companies	Energy cost remains high even after installation of energy efficient technologies	Lowering the unit cost per kWh	

Chapter 5: BIO-ENERGY RESOURCES

5.1 Introduction

Bioenergy is fuel developed from organic materials and is considered a renewable and sustainable source of energy. It exists in three different forms: solid (biomass), liquid (biofuels), and gaseous (biogas). Sources of bioenergy include : biomass (firewood, charcoal, briquettes, pellets, plant residues), biofuels (bioethanol and biodiesel), and gas (biogas, landfill gas, and syngas). One significant advantage is that it can be easily stored, enabling energy production and use on demand. Bioenergy use falls into two main categories: “traditional” and “modern.” Traditional use refers to the combustion of biomass, such as wood, animal waste, and traditional charcoal. Modern bioenergy technologies include liquid biofuels produced from bagasse and other plants; bio-refineries; biogas produced through anaerobic digestion of residues; and wood pellet heating systems using energy-saving jikos/improved cookstoves.

5.2 Bioenergy Situations

5.2.1 Woodfuel

There is a high dependency on local woody resources (firewood and charcoal). According to the SETA Household Energy Survey baseline (March 2023), 65% of households (HHs) in Kilifi consider firewood as their primary fuel, with 47% of HHs relying solely on firewood without a secondary fuel. Charcoal is the primary fuel for 30% of households, and it is the main secondary fuel in Kilifi, especially in urban areas where it is used by 77% of HHs, followed by LPG, which is used by 18% of urban households.

The total amount of woodfuel consumed by households and institutions for heating and cooking was 9,758,553,090 MJ (firewood and charcoal), while the consumption of fossil fuels (coal, fuel oil, diesel, and kerosene) in 2019 was 8,184,940 GJ. Coal contributed 67.5%, fuel oil 30.2%, diesel 0.05%, and kerosene 2.3% of the energy used by 14 major industries in Kilifi County.

The consumption of woodfuel for these companies was 44,750 GJ, with cashew nut husks and briquettes contributing 1.92% and 98.08%, respectively. The amount of renewable energy consumed in industrial process heating by these industries in 2019 was just 0.54%. Coal was used exclusively in cement factories, contributing 93.82% of the energy consumed in industries in 2019.

Significant efforts are required to increase the use of renewable energy from 0.76% to at least 80% by 2030. The situation is complicated by Kilifi County’s forest cover of only 7.67% (Kiarie N., 2016), which is below the national government’s target of 10%. In 2012, the demand for wood fuel in Kilifi County was 1,006,794 m³, with a corresponding supply of 641,355 m³, leaving a deficit of 57.9% (Ministry of Environment, Water, and Natural Resources, July 2013).

5.2.2 Biofuels

Worldwide, the most widely used biofuels for transport are bioethanol and biodiesel. Biofuels could play an important role in the transport sector as alternatives to fossil fuels. While biofuels have existed longer



than modern automobiles, cheap gasoline and diesel have long kept them on the fringe. In Kenya, the use of bioethanol as a household cooking fuel has been successfully piloted. Bioethanol is used as a clean alternative to kerosene for household cooking. Koko Network, a company that distributes bioethanol for cooking, has installed distribution points across major urban centres in the country. A private investor has proposed setting up a cassava processing plant in Kilifi County for bioethanol production.

The use of *Jatropha* for biodiesel production was piloted by smallholder farmers in Kilifi County in areas such as Mida–Majaoni, Mijimboni, Kakuyuni in Malindi, and Bomani in Magarini. However, this initiative has not been successful due to the high production costs, making biodiesel more expensive than petroleum diesel.

5.2.3 Biogas

Biogas is a clean cooking fuel. However, its penetration in the County is very low. According to Mtwapa Energy Centre, the number of domestic biogas plants installed in Kilifi is less than 300. In 2017, the Ministry of Energy installed 27 domestic biogas plants of 10 m³ capacity in Kilifi County.

During monitoring and evaluation, it was found out that 8 of the biogas plants were not working, mainly due to challenges related to either inadequate water, cow dung, or both. To avoid such failures, the Kilifi County Government intends to develop a GIS database of households which that have the potential to install biogas plants.

A pilot study was carried out in Ganze sub-county, sampling 264 households. In Ganze sub-county, about 99% of the households use woodfuel for cooking (Kilifi County Govt and GROOTS Kenya, December 2019). Of the households surveyed, 171 (64.7%) were found to have the potential for installation of domestic biogas systems (Kilifi County Government, Department of Energy, March 2020).

The criteria of for assessing the potential is are based on the number of cattle owned and proximity to a water source. The minimum number of cattle required was 10, while the longest time taken to fetch water was limited to 1 hour. The results of the study showed that 64.7% of the households had enough feedstocks for biogas generation. Promoting biogas use will also reduce fuelwood and charcoal consumption and contribute to Kilifi County Government's efforts to reduce deforestation, forest degradation, and greenhouse gas emissions.

Determination of the Size of Biogas Plant

Digester Size: For determining biogas digester size, the following experimental values from past projects in other countries can be used as a reference.

$$V_{dc} = 1.89 \times N_c$$

$$V_{dh} = 1.89 \times N_h$$

Where,

V_{dc} : Volume of cow dung digester (m³)

V_{dh} : Volume of human waste digester (m³)

N/B

The above formula is based on zero-grazing, where a cow produces 20 kg of cow dung daily. For digesters connected to human waste, a rough estimation of volume is calculated as 0.1 m³ per adult person. This estimation assumes diluted human waste (feces, urine, and flush water) amounts to 3.3 L/day, with a retention time (RT) of 30 days.

The table below shows various digester sizes based on the above formula, as per the GIZ Biogas Construction Manual.

Table 95: Digester Size by Daily Cow Dung Production

Digester Size (m ³)	Dung/day (kg)	No. of Cows*	Volume of Gas Produced (m ³)
8	100	5	3
12	150	7	4.5
16	200	9	6
24	300	13	9
32	400	17	12
48	600	25	18
59	740	31	22
71	900	38	28
80	1100	46	34
124	1500	63	46

(REREC, Ministry of Energy and Petroleum, 2014)

*Amount of cow dung produced by a cow is assumed to be 20–24 kg/day. This amount will vary according to status of cows.

Households and Institutional Biogas System

- There are various sizes of cooking stoves, ranging from small household sizes of 1–2 kW power (approx. 0.5 m³/h) to stoves for institutional use with a power of over 10 kW (more than 4 m³/h).
- Kilifi County Government plans to install household and institutional biogas systems for cooking. A significant number of biogas systems installed in the country are not working, mainly due to mainly a lack of enough feedstock or improper feeding of the biodigester.
- For the successful implementation of the planned installation of household and institutional biogas systems, the design of the systems should be done professionally, based on the confirmed availability of feedstock.
- For households, the preferred sizes should be 8 m³ or 12 m³, for daily feeding requiring daily feeding of either 100 kg or 150 kg of cow dung, depending on the available feedstock. For institutions, the minimum size should be 50 m³ for daily feeding of 300 kg of cow dung.



5.2.3.1 Biogas for Households

A biogas feasibility study conducted in Ganze sub-county indicated that 64.7% of households have the potential to install a biogas plant. These households typically own over 10 cattle, and the furthest distance to a water source was about 1 hour. Magarini sub-county, which shares the same ecological zone as Ganze, is expected to have a similar potential for domestic biogas uptake. The total number of households in the two sub-counties is 59,754 (Census report, 2019). According to Mtwapa Energy Centre, the number of biogas plants is less than 300.

The number of households with potential for biogas uptake in the two sub-counties is estimated at 38,660. Kilifi County Government aims to increase the uptake of biogas plants at the household level to 64.7% (19,330 households) by 2027.

The planned plant digesters will range between 8 and 12 cubic metres. While the estimated unit cost of KES 150,000 per plant presents a substantial financial investment, totaling KES 2,899,500,000 for the construction of 19,330 units, the county government remains undeterred.

Through strategic partnerships with forged with various stakeholders—national government, development partners, and the private sector—the mobilization of these resources is within reach, demonstrating a collective commitment to realizing this ambitious vision by 2030. Spearheaded by the collaborative efforts of the Energy Directorate and the Department of Livestock, this initiative not only promises to revolutionize energy access but also underscores the county's dedication to the eventual elimination of wood fuel.

Activities

The biogas project targeting 19,330 households will encompass several coordinated activities aimed at successful implementation and long-term sustainability. These activities include:

- a) **Partnerships and Resource Mobilization:** Strengthening partnerships with relevant stakeholders, including government agencies, NGOs, and the private sector, to mobilize financial and technical resources for project success.
- b) **Community Sensitization and Engagement:** Organizing awareness campaigns and community meetings to educate residents about the benefits of biogas technology, garner support, and ensure active participation. Demonstration units will be constructed at select households to showcase the technology.
- c) **Technical Design and Procurement:** Collaborating with experts to design biogas digesters tailored to household needs, followed by procuring necessary materials.
- d) **Construction and Installation:** Overseeing the construction and installation of biogas digesters, ensuring adherence to technical specifications and safety standards.
- e) **Training and Capacity Building:** Providing training to households on biogas system operation, maintenance, and safety protocols. Arrangements will also be made to train local artisans in construction and maintenance skills.
- f) **Sustainability Planning:** Developing strategies for the sustainable management and maintenance of biogas systems, including ongoing support and repairs.



- g) **Knowledge Sharing and Replication:** Documenting project experiences and lessons to facilitate knowledge sharing and encourage replication in other communities.
- h) **Monitoring and Evaluation:** Establishing mechanisms to track project progress, measure impact, and address challenges, with periodic evaluations informing adjustments and improvements.

Costing

Table 96: Costing—biogas project for households

Cost component	Unit	Unit cost (KES) in 2024	No. of units	Discounted Cost (KES)
Capital investment	No of biogas digesters	150,000	19,330	2,899,500,000
Partnerships and Resource Mobilization, Community Sensitization and Engagement, Training and Capacity Building, M&E	Lumpsum			10,000,000
Total				2,909,500,000

5.2.3.2 Biogas for institutions from human waste

Biogas generation from human waste is still a relatively nascent technology in Kenya. However, in other parts of the world like China, Nepal and India this technology is well entrenched. The technology is thus well proven and functional (Mugambi 2014). In Kenya, there are institutions already generating biogas from a blend of human, kitchen and animal wastes (a good example is St. Mary High School in Taita Taveta). Overall, the uptake of human waste-fed biogas systems in Kenya will be driven by a combination of energy access needs, environmental considerations, health benefits, government support, and awareness creation. As awareness grows and technological advancements continue, biogas from human waste is expected to play an increasingly important role in provision of the institution's cooking energy requirements.

As previously mentioned in this document, there are 32 secondary schools in the county with over 700 enrolments. These institutions should be investigated for the possibility of installing a biogas plant. Of these institutions, those with which have cattle stands a better chance of installing a successful biogas plant. With a proactive approach and strategic partnerships involving the national government, development partners, and the private sector, the county government is confident that biogas systems can be successfully installed at these institutions. This intervention is expected to serve as a catalyst for expanding the adoption of this technology across more institutions in the county.

5.2.4 Municipal Solid Waste

Municipal waste consists of solid waste, including durable and nondurable goods, containers, food scraps, yard waste, and inorganic waste from homes, institutions, and businesses. It also includes waste generated by manufacturing, agriculture, mining, construction, and demolition debris, as well as sludge and liquid waste from water and wastewater treatment facilities, septic tanks, and sewerage systems, and slaughterhouses.

A WtE facility can be installed to save space occupied by waste in landfills, manage waste sustainably, generate electricity, and reduce the release of methane gas and toxic chemicals into groundwater.



Kilifi County has three municipal solid waste (MSW) dumpsites, namely Mayungu in Malindi, Katsimini in Mariakani, and Mtondia near Kilifi town. Mtondia and Mayungu are open dumpsites, while Katsimini is an incomplete landfill. At 100% efficiency, Kilifi County can collect and transport a total of 770 tonnes per day of MSW to these dumpsites (Kilifi County Government, Department of Water, Environment and Natural Resources, 2019).

This MSW has the potential to generate 13.5 MW of electricity (County Government of Kilifi, October 2019).

Landfill Gas Capture (LFGC): Sanitary landfilling (SLF) is a widely adopted and accepted method of treating waste, especially in developing countries where it's often the only available method of controlled waste treatment. Kilifi County does not have well-constructed dumpsites that can capture Landfill Gas (LFG) for energy use. Though SLF is more advanced and environmentally friendly compared to open dumping, it is still associated with negative environmental impacts. Thus, LFG capture is incorporated into SLFs to harness methane and mitigate environmental pollution. LFGC projects require a high content of reactive organic waste. LFG consists of 45–55% methane, with the remainder usually CO₂, making it suitable as a fuel for heat or power generation. LFG is particularly suited for waste quantities of over 10,000 metric tonnes per year.

Anaerobic Digestion (AD) for Biogas Production: Anaerobic (without oxygen) decomposition of biodegradable organic waste produces biogas. The waste is fed into an anaerobic digester where micro-organisms convert organic matter into biogas and a solid-liquid residue called digestate or slurry. Methane gas, which makes up 50–75% of biogas, is the main energy carrier. AD is best suited for homogenous organic waste such as source-separated household waste, market waste, and garden waste. Co-digestion with wastewater sludge or agricultural residue can increase feedstock availability. Biogas can be used to generate heat directly or to produce heat and electricity in a combined heat and power (CHP) plant. AD is suited for annual waste quantities of more than 10,000 metric tonnes. However, since Kilifi County does not segregate its solid waste, it is not suitable for biogas production through anaerobic digestion.

Incineration: Incineration involves the controlled burning of waste, reducing its mass by about 75% and its volume by about 90%. This process renders the waste chemically inert, and the heat generated can be harnessed for electricity production, heating/cooling, or industrial processes. Incineration is suitable for mixed and untreated waste with a minimum lower calorific value (LCV) of 7 MJ/kg and for annual waste quantities of over 150,000 metric tonnes.

Co-processing: Co-processing involves utilizing waste materials from industrial processes to substitute mineral resources (material recycling) or traditional fuel materials like coal or fossil fuels for heat generation (energy recovery). It requires fairly homogeneous waste streams and is suitable for annual waste quantities of over 10,000 metric tonnes.

Alternative Technologies: Pyrolysis & Gasification: These technologies thermally degrade waste in oxygen-controlled environments, leading to the formation of pyrolysis gas (syngas) and solid carbon. The process includes four steps: smoldering, pyrolysis, gasification, and incineration. Pyrolysis and gasification are suitable for specific waste streams, such as industrial waste, but are unsuited for MSW due to the high cost of the technology, the required expertise, and the fact that the technology is still nascent. These technologies are suitable for annual waste quantities of over 10,000 metric tonnes.



Table 97: Assessing the Feasible W2E Technology for MSW

Parameter	Kilifi MSW	Technology Options				
		Anaerobic Digestion	Landfill Gas Capture	Incineration	Co-processing	Pyrolysis & gasification
Overall level of waste mgt	Systematic collection & disposal exists; recycling unsystematic					
Waste composition	Organic & non-organic wastes mixed					
Calorific value	Unknown; assumed to be <7 MJ/kg with moderate inorganic content					
Suitable annual waste quantities*	Mtondia: 52,693,536.15 kg					
	Kitsimini: 2,676,390.81 kg					
	Mayungu: 29,088,987.98 kg					
Proximity to energy users	Feasibility of energy evacuation to evaluated					
Financing of W2E facility	CIDP allocations/ PPP arrangements?					

Project 1: Project Description

The feasible W2E technology

Figure 63: Interpreting the decision-making matrix

Color code	Implication
	Technology most suitable
	More information is need for complete suitability assessment
	Technology unsuitable

→ The most feasible technology, based on the 6 parameters, is Landfill Gas Capture at Mtondia & Mayungu, subject to further evaluation of parameters 3, 5, & 6. For Kitsimini, the waste generated is insufficient.

Estimating the Landfill Gas (LFG) Potential (Tsunatu et. al. (2015))

In bio-chemical conversions, only the biodegradable component of organic matter contributes to energy generation.

- Total Waste = W tonnes
- Total Organic / Volatile Solids: VS = 50% (typical)
- Organic biodegradable proportion = 55% (County Directorate of Environment)
- Total bio-degradable organic matter = $0.5 * 0.58 * W = 0.29 W$ tonnes
- Digestion efficiency = 60% (typical)
- Typical gas yield in $m^3 = 0.8 m^3/kg$ of organic matter digested; hence: $(0.29 W * 1,000) kg * 0.8 m^3/kg * 0.6 = 139.2W m^3$
- Calorific value of LFG = $5,000 kcal/m^3$ (typical) = $5.81 kWh/ m^3$ (1kWh = 860 kcal)
- Hence total energy recovery potential in kWh = $139.2 W * 5.81 = 808.75 W$

Table 98: Landfill Gas Potential (LFGP) at the 3 dumpsites

As at 31/12/2023	Dumpsite		
Parameter	Mtondia	Mayungu	Kitsamini
Total Waste (W) tonnes at 31/12/23	417,396.37	230,081.88	21,561
Typical gas yield potential in m ³ (139.2W)	58,101,574.70	2,027,397.70	3,001,291.20
Total energy recovery potential in kWh (808.75 W)	337,569,314.24	86,078,720.45	17,437,458.75
Actual recovery potential in kWh at a typical conversion efficiency of 30% (242.63 W)	101,272,881.25	5,824,766.54	5,231,345.43

Source: Author

Table 99: Landfill Gas Potential (LFGP) at the 3 dumpsites

Daily waste generation & disposal @ 70% efficiency	Dumpsite		
Parameter	Mtondia	Mayungu	Kitsamini
Total Waste (W) tonnes	247.63	137	12.58
Typical gas yield potential in m ³ (139.2W)	34,469.51	9,028.58	1,750.76
Total energy recovery potential in kWh (808.75 W)	200,267.38	110,555.79	10,171.91
Actual recovery potential in kWh at a typical conversion efficiency of 30% (242.63 W)	60,081.45	33,167.42	3,051.64
Net power generation potential in kW = (242.63 W/24) = 10.11 W (assuming plant is running for 24 hours)	2,503.50	1,382.03	127.16
Net power generation potential in MW	2.5	1.38	0.127

Source: Author

Costing (Palacio et. al. (2018) <http://dx.doi.org/10.5772/intechopen.79235>)

Table 100: Project Costing

Dumpsites & annual waste outputs (tonnes) per annum	Cost component (\$) per tonne of waste per year					
	Capital investment \$		O & M \$		Total \$	
	min	max	min	max	min	max
	10	30	1	3	11	31
Mtondia (247.6*365) = 90,374	903,740	2,711,220	90,374	271,122	994,114	2,982,342
Mayungu (137*365) = 50,005	500,050	1,500,150	50,005	150,015	550,055	1,650,165
Kitsamini (12.58*365) = 4,591.7	45,917	137,751	4,592	13,775	50,509	151,526

Source: Author

Project 2: Project Description

The feasible W2E technology—Cogeneration

The feasibility study of WtE project (Kilifi County Government, Directorate of Energy, October 2019) was carried out to establish the technical and financial of generating electricity from the Municipal Solid

Waste (MSW) generated in Kilifi County. The study also considered the possibility of sourcing MSW from dumpsites situated in Mombasa County. The study analysed technical and financial factors and the results showed that the project is viable. The technical factors analysed include the amount of MSW generated per day, physical and chemical properties of the MSW and the project site, while the financial factors analysed include the investment cost, annual cash flow, pay-back time, net present value and internal rate of return. The costs are based on estimations. The findings of this study are as indicated below.

1. The amount of MSW used this study is 489,576 kg/day and 1,500 tonnes/day in scenarios 1 and 2, respectively. In used in scenario 1, the MSW is solely sourced from Kilifi County whereas in scenario 2 MSW is sourced from Kilifi County and Mombasa County.
2. The calorific value of the MSW was found to be 10.67 MJ/kg which is above the minimum recommended value of 7 MJ/kg.
3. The total amount of electrical power to be produced annually by the WtE plant will be 108,093.33 MWh (scenario 1) and 335,000 MWh (scenario 2). The installed capacity WtE plant would be 13.5 MW (scenario 1) and 41.8 MW (scenario 2).
4. The study indicates that the most suitable site identified for the WtE plant is Katsimini dumpsite in Mariakani ward, Kilifi County, which is 2 km from a power transmission substation and close to Mombasa–Mtito Andei highway where there some many upcoming urban centres. The area has been designated for development of industrial park. Table 88 shows the distances between dumpsites and plant site in Mariakani, Kilifi Count.

Table 101: Distances between the Dumpsites and the Plant Site

Dumpsites	Distances in kilometres
Kilifi County: Mayungu in Malindi—Katsimini in Mariakani	139
Kilifi County: Mtondia in Kilifi—Katsimini in Mariakani	75
Mombasa County: Mwakirunge—Katsimini in Mariakani	58
Mombasa County: Shonda—Katsimini in Mariakani	57

The investment cost (Capital Cost or project cost) for is KES 7,666,959,910 (US\$ 74036348.30) and KES 23,761,239,390 (US\$ 229,451,492.7) for scenarios 1 and 2 respectively. The implementation of the project will be based on PPP system. The equity arrangement would be 20% local and 80% foreign.

Recommendations

WtE technologies offer a solution for waste disposal problems. While the primary purpose of a WtE plant is to manage municipal solid waste, energy production is a valuable part of the equation in order to maximize energy efficiency, environmental benefits, greenhouse gas mitigation, and economic revenue. Since the study shows that the WtE plant is technically and financially viable, in its quest to among the first to modernise their MSW disposal system, it is recommended that the County Government of Kilifi should:

1. Implement the project through PPPs. Under a PPP, the county government will float a tender for design and build of a WtE plant. The PPP will either have a Build-Operate-Transfer (BOT) ownership/operational structure or Build-Own-Operate (BOO) structures.



2. Since the WtE plant will be part of Kilifi County MSW management system, it is advisable to ensure the county government has shares in the plant and representation on the board. This will keep the county government in the loop of all decisions and development in the management of the plant. The county government will acquire the shares in the plant through:
 - a) Securing and preparing the site for the plant location, including provision of water, roads, and legal land ownership documents.
 - b) Engage the community living around the project in sensitization programmes on the WtE project for a buy in and to secure consensus and support for the project.
 - c) Continuing with their normal collection and transportation of the MSW to the dumping sites. In this study, costing for transportation of MSW from a radius of 50 km from the WtE plant was provided for. Further analysis needs to be made to identify appropriate sites which will act as holding yards for the MSW.
3. Work closely with the investor in acquiring the necessary permits and licences for the setting up of the plant, and tax exemptions for power generation equipment and machinery.
4. Propose that the County Government of Mombasa allow the processing and disposal of its MSW to be done at the WtE plant in Kilifi. The County Government of Mombasa will be requested to officially allow the investor to collect and transport the MSW from Mwakirunge and Shonda dumpsites to the WtE plant for processing and disposal free of charge.

5.3 Pathways for Sustainable Production of Bioenergy Resources

Objective 1: Policies, Laws, Institutional Frameworks and Capacity Exist and are Clear and Consistent.

Enhance policy, regulatory, and institutional frameworks for effective delivery and coordination of bioenergy programmes.

Desired outcomes include:

- a) The County Bioenergy Committee (CBC) constituted and official launched;
- b) Organizational mandates in bioenergy development as well as coordination and leadership in implementing policy and regulatory requirements are harmonised at county levels;
- c) A coordination desk established at the county government, and TORs developed and endorsed by all relevant stakeholders;
- d) Operational budget set aside;
- e) Collaboration charter developed and endorsed by non-state actors and oversight provided by the CBC;
- f) Bioenergy industry associations strengthened; and
- g) Diverse actors—both non-state and state agencies—registered and coalesce around bioenergy-specific innovation platforms to champion bioenergy planning and deployment;
- h) Forest management policies recognize and operationalize sustainable woodfuel production as one of the uses of forests and trees;
- i) Bioenergy producers trained in sustainable bioenergy production practices;
- j) Stakeholders sensitized on the importance of sustainable bioenergy management.



Objective 2: Mobilizing Financial Resources for Local Bioenergy Development.

Desired outcomes include:

- a) Funding secured from multilateral organizations;
- b) Development partner support attracted to leverage efficient sourcing from smallholder farmers;
- c) Climate financing unlocked to develop the bioenergy ecosystem at different stages of the value chain;
- d) Results-based financing deployed to enhance bioenergy enterprise economics;
- e) Implementation of bioenergy activities by various organizations operating in Kilifi County harmonised to create synergy;
- f) Sending Funding proposals sent for bioenergy activities to various financiers, including NGOs, foundations, banks, bilateral partners, donor agencies, National Government Constituency Development Fund (NG-CDF), County Women Representative Fund.

Objective 3: Comprehensive Mapping of the County's Bioenergy Resources with Potential for Bioenergy Development.

Desired outcomes expected:

- a) GIS inventory database of feasibility studies for developing bioenergy feedstock resources established, including active players in resource development;
- b) Criteria for continuous updates of the GIS database by research organizations, independent consultants, and government entities established;
- c) Bioenergy sector-specific studies conducted, including:
 - Biofuel production feasibility study;
 - Sustainable woodfuel production feasibility study;
 - Feasibility study on production of briquettes for industrial heating;
 - Feasibility study for reticulation of LPG in upper-end estates of Kilifi County.
- d) Accurate forest-cover and land-use data made available.

Objective 4: Increase the Share of Sustainable Bioenergy in the National Energy Mix to 80% by 2030.

Desired outcomes for increased sustainable bioenergy in the county energy mix include:

- a) Sustainable bioenergy feedstock production promoted, including on-farm growing of energy trees and crops, and establishing fast-growing tree plantations in public places by county governments and the private sector, including peri-urban areas;
- b) Production of forest and non-forest biomass fuels;
- c) Contribution made to the county's climate change and forest cover targets;
- d) Under-served demands in selected industries for heat and power met by expanding the supply of biomass feedstocks;
- e) **Farmland and dryland tree-planting initiative:** This programme promotes tree planting outside public forest lands to contribute to the Realisation of 10% forest and tree cover by 2030.



It also introduces commercial tree species in dry areas of Kilifi County to control desertification and improve livelihoods;

- f) **Forest plantation development:** This programme aims to meet the growing demand for wood in the county and contribute to sustainable management of public plantations;
- g) **Microforestry:** Kenya faces a wood supply crisis due to population growth and economic expansion. Most regions consume much more wood than they grow leading to deforestation and increasing wood prices. And with land becoming scarce, expansion of large plantation forestry cannot keep up. The high demand for wood products which includes woodfuel provides Kilifi County an opportunity to grow Microforestry sector. While often overlooked, millions of farmers are already growing trees. Nearly half of Kenya's local wood supply comes from small farmers. But on their own, individual farmers aren't achieving commercial quality or growth rates, and are disconnected from high-value industrial markets. Yet small-scale farmers offer effectively limitless land and labour, and live on the doorstep of every major urban market. Small-scale farmers, though, offer a solution to the County's wood supply crisis. Collectively, small farmers possess limitless land and labour resources to plant billions of trees. The County Government to provide farmers across the forestry value chain, from seedlings to the production and marketing wood products. This model is lower-cost and more-scalable forestry, an environmentally-sustainable wood supply and improving livelihoods by generating life-changing income for millions of farmers.
- h) **Agroforestry:** This focuses on integrating trees into agricultural landscapes to preserve their essential roles in ecosystems, providing products and services to both rural and urban communities;
- i) Further research needed to determine the optimal balance of residues (agricultural waste) that should remain in the field or forest to maintain soil fertility and improve soil conservation.

Objective 5: Support and Facilitate Private Sector Involvement in Bioenergy Development.

Desired outcomes include:

- a) Ease of doing business improved;
- b) Private sector participation in bioenergy development strengthened;
- c) Standards and regulations for bioenergy technologies developed;
- d) Market with low-interest loans for local bioenergy producers stimulated;
- e) Fiscal and investment incentives developed and implemented;
- f) Putting a price on wood Pricing wood resources and reinvesting revenues (e.g., from wood-cutting taxes, licensing fees, certifications) to ensure sustainable forest management.



5.4 Envisioned Progression for Sustainable Production of Bioenergy Resources

5.4.1.1 Progression on Enhancement of Policy, Regulatory, and Institutional Frameworks for Effective Delivery and Coordination of Bioenergy Programmes.

Year	2024	2025	2026	2027	2028
Enhancement and harmonisation of policy, regulatory, and institutional frameworks at the county government level.					
County Bioenergy Committee (CBC) constituted.					
Clear delivery and coordination desk established at the county government, with TORs developed and endorsed by all relevant stakeholders.					
Operational budget set aside.					
Collaboration Charter developed and endorsed by non-state actors, with oversight provided by the CBC.					
Bioenergy industry associations strengthened.					
Diverse actors—both non-state and state agencies—registered and coalesced around bioenergy-specific innovation platforms to champion bioenergy planning and deployment.					
Forest management policies recognize and operationalize sustainable woodfuel production as a forest and tree use.					
Bioenergy producers trained in sustainable bioenergy production practices.					
Stakeholders sensitized on the importance of sustainable bioenergy management.					

5.4.1.2 Progression on Mobilizing Financial Resources for Local Bioenergy Development.

Year	2024	2025	2026	2027	2028
Funding secured from multilateral organizations.					
Development partner support attracted to leverage efficient sourcing from smallholder farmers.					
Climate financing unlocked to develop the bioenergy ecosystem at different stages of the value chain.					
Results-based financing to enhance bioenergy enterprise economics deployed.					
Implementation of bioenergy activities by various organizations operating in Kilifi County harmonised to create synergy.					
Funding proposals sent to various financiers, including NGOs, foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund.					

5.4.1.3 Progression on Mapping of the County's Bioenergy Resources with Potential for Bioenergy Development.

Year	2024	2025	2026	2027	2028
GIS Inventory database of feasibility studies for bioenergy feedstock resources established, including active players in resource development.					
Biofuel production feasibility study completed.					
Feasibility study on sustainable woodfuel production completed.					
Feasibility study on briquette production for industrial heating completed.					
Accurate forest cover and land-use data made available.					



5.4.1.4 Progression on Increasing the Share of Sustainable Bioenergy in the County Energy Mix to 80% by 2030.

Year	2024	2025	2026	2027	2028
Sustainable bioenergy feedstock production promoted. On-farm growing of energy trees and crops, and fast-growing tree plantations established in public spaces by county governments and the private sector, including peri-urban areas.					
Production of forest and non-forest biomass fuels.					
Contribution to the county's climate change and forest cover targets made.					
Underserved demands in selected industries for heat and power met by expanding the supply of biomass feedstocks.					
Farmland and dryland tree-planting initiative launched, promoting tree planting outside public forest lands to achieve 10% forest and tree cover by 2030.					
Forest plantation development: Development of commercial forest plantations to meet growing wood supply needs in the county. Contributes to re-stocking and sustainable management of all public plantations.					
Microforestry: Support for small farmers to collectively carry out commercial tree growing.					
Agroforestry: Integration of trees into agriculturally productive landscapes to provide a range of products and services to rural and urban people.					
Further research on the balance of agricultural waste residues that should remain in the field or forest to maintain soil fertility and carbon content and improve soil conservation.					

5.4.1.5 Progression on Support and Facilitation of Private Sector Involvement in Bioenergy Development.

Year	2024	2025	2026	2027	2028
Ease of doing business improved.					
Private sector participation in bioenergy development strengthened.					
Standards and regulations for bioenergy technologies developed.					
Market for low-interest loans for local bioenergy producers stimulated.					
Fiscal and investment incentives developed and implemented.					
Pricing on wood resources implemented, with revenues reinvested in sustainable forest management through wood cutting taxation, licensing fees, and certifications.					

5.4.1.6 Progression in Installation of Domestic and Institutional Biogas Systems for Heating and Cooking

1. Installation of Domestic Biogas Systems

Year	2019 (Census)	2022 (Projected)	2025 (Projected)	2027 (Projected)
Number of biogas Systems	303	967	1364	3534

2. Installation of Institutional Biogas Systems

Year	2023	2024	2025	2026	2027	2028
No. of Secondary Schools	132	132	132	132	132	132
Number of Biogas Systems Installed	0	0	0	2	4	7
No. of Tertiary Institutions	53	53	53	53	53	53
Number of Biogas Systems Installed	0	0	0	1	2	3

5.4.2 Estimated Investments for Bioenergy Resources

Table 102: Capital Cost of Acquisition of Clean Cooking Solutions by Households

Cost component	Specifications	Unit cost (KES)	Units	Cost (KES) in Millions
Enhance Policy, Regulatory and Institutional Frameworks for Effective Delivery and Coordination of Bioenergy Programmes.	Enhancement and harmonisation of policy, regulatory and institutional frameworks at the county government level	3	1	3
	County Bioenergy Committee (CBC) constituted	0.5	1	0.5
	Delivery and Coordination desk established at county government, and TORs developed and endorsed by all relevant stakeholders;	1	1	1
	Operational budget set aside;	3.15	1	3.15
	Collaboration Charter developed and endorsed by non-state actors and oversight provided by the CBC;	1	1	1
	Bioenergy industry associations strengthened; and	0.1	10	1
	Diverse actors—both non-state and state agencies—registered and coalesce around bioenergy-specific innovation platforms to champion bioenergy planning and deployment	-	-	-
	Forest management policies recognize and operationalize sustainable woodfuel production as one of the uses of forests and trees.	3	1	3
	Bioenergy producers trained in sustainable bioenergy production practices.	0.01	210	2.1
Sub-Total				14.75
Mobilizing Financial Resources for Local Bioenergy Development.	Funding secured from multilateral organizations, NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	100	5	500
	Development partner support attracted to leverage efficient sourcing from smallholder farmers;	20	5	100
	Climate financing unlocked to develop the bioenergy ecosystem at different stages of the value chain;	20	5	100
	Results-based financing that could enhance bioenergy enterprise economics deployed	20	5	100
Sub-Total				800
Mapping of the County's Bioenergy Resources with Potential for Bioenergy Development	GIS Inventory database of feasibilities studies for development various covering bioenergy feedstock resources established including active players in resource development	5	1	5
	Biofuel production feasibility study	3	1	3
	Feasibility study on sustainable woodfuel production	3	1	3
	Feasibility study on production of briquettes for industrial heating	3	1	3
	Accurate forest-cover and land-use data made available.	5	1	5
Sub-Total				25
Increase Substantially the Share of Sustainable Bioenergy in the County Energy Mix to 80% by 2030	Sustainable bioenergy feedstock production promoted. On-farm growing of energy trees and crops, and fast-growing tree plantations established in public places by county governments and private sector, including peri-urban areas;	5	5	25
	Production of forest and non-forest biomass fuels;	5	5	25
	Under-served demands in selected industries for heat and power met by expanding the supply of biomass feedstocks.	2	2	10
	Farmland and dry land tree-planting initiative: This programme promotes tree planting outside public forest lands in order to contribute to the Realisation of 10% forest and tree cover by 2030.	5	5	25
	Forest plantation development: This programme deals with development of commercial forest plantations to meet the growing needs of wood supply in the county. It contributes to re-stocking and sustainable management of all public plantations.	5	5	25
	Microforestry: Supporting, small farmers Collectively to carry out commercial tree growing	5	5	25



Cost component	Specifications	Unit cost (KES)	Units	Cost (KES) in Millions
(Continued)	Agroforestry: integrating trees into agriculturally productive landscapes to provide a range of products and services to rural and urban people.	2	5	10
Increase Substantially the Share of Sustainable Bioenergy in the County Energy Mix to 80% by 2030	Further research is needed to determine the proper balance of residues (agricultural waste) that should remain in the field or in the forest to maintain soil fertility and soil carbon content, and improve soil conservation.	3	1	3
	Sub-Total			123
Support and Facilitate Private Sector Involvement in Bioenergy Development	Ease of doing business improved;	2	4	8
	Private sector participation in bioenergy development strengthened;	2	5	10
	Standards and regulations for bioenergy technologies developed;	2	5	10
	Market with low-interest loans for local bioenergy producers stimulated;	2	5	10
	Fiscal and investment incentives developed and implemented.	2	5	10
	Putting a price on wood resources and reinvesting revenues (for example from wood cutting taxation, licensing fees, certifications) to help ensure sustainable forest management.	2	4	8
	Sub-Total			56
Installation of Domestic and Institutional Biogas Systems for Heating and Cooking	Installation of 8m ³ –12m ³ domestic Biogas Systems for Heating and Cooking	150,000	3534	530.1
	Installation of 12m ³ Institutional Biogas Systems for Heating and Cooking	450,000	19	8.55M
	Sub-Total			532.8
	Grand Total			1,557.4

5.4.3 Risk and mitigation

Table 103: Risk management in achieving the energy efficiency targets

Risks	Impact	Mitigation	Responsibility
Exchange rate risks related to the projects, especially for equipment sold in international markets	Avoidance of buying efficient equipment	Local manufacture of energy efficient equipment	Government
Regulatory, governance and contract uncertainties with equipment suppliers, contractors and third parties who may be necessary to implement projects;	Lack of confidence in the organisations management to issue contract to Energy Service Companies	Strengthen the regulatory and governance of contracts	MoEP
Limited access to capital/credit, which often implies a very short-term payback approach to EE project evaluation especially for small micro enterprises	Inability to pay for energy efficient technologies	Increasing the credit tenor Creation of a fund to support energy efficiency projects	Financial Institutions, CSOs, Development partners
The mismatch of investment costs and energy savings costs, budget and credit constraints and the opportunity costs of exhausting one's credit limits on energy efficiency rather than on increasing sales;	No budget set aside for investing in energy efficient projects	Inclusion of budget of implementation of energy efficient projects in the investment plan	Government
Availability of energy is a critical issue: Even when manufacturing firms are willing to assume a high unit cost per kWh, energy supply is often not only insufficient, but also unreliable, giving rise to costly backup and self-generation (e.g. smelting and energy dependent, continuous chemical processes) in many companies	Energy cost remains high even after installation of energy efficient technologies	Lowering the unit cost per kWh	

Chapter 6: PROJECTS AND PROGRAMMES

6.1 Energy Access

6.1.1 Projects and programmes to be implemented by the national government

1 Energy Programmes and Projects for Access to Electricity

The national government is responsible for the construction of electrical power generation systems, and transmission, and distribution of electrical power supply systems. These projects/programmes will be implemented by MoEP through its parastatals, namely Kenya Power, KETRACO, and REREC. The projects to be implemented are:

- **Project 1:** Facilitating universal electricity access in Kilifi County households by 2030.
- **Project 2:** Ensuring universal access to electricity in public institutions (Government administrative buildings, learning, and health facilities).

Summary

Table 104: Summary of Projects and Programmes to be Implemented by National Government

S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)—Inflation discounted cost	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
1.	To ensure all households (HHs) will have access to electricity by 2030	Facilitating universal electricity access in Kilifi County households by 2030.	2024–2030	Resource mobilization, infrastructure development, delivery of electrification solutions	Kilifi County Government Kenya Power, REREC, KETRACO, Development partners, Private sector	Cost dependent of supply option selected Option 1 USD. 64.7 M Option 2: USD 198.6 M Option 3 USD 210.5 M	County govt, National govt., Development partners, Private sector	181,000 households	New
	To connect 12,809 HHs	Last mile connectivity	2024–2025	Transformer maximization and extension of low voltage lines	Kenya Power	-	AFD/EU/EIB	12,809	New
2.	To connect Primary schools to electricity	Enhancing universal access to electricity in all learning centers	2024–2028	Site assessment, planning & design Installation and commissioning	REREC	KES 243.4 M	National government through its various agencies.	96 primary schools	New



S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)— Inflation discounted cost	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
3.	To connect secondary schools to electricity	Enhancing universal access to electricity in all learning centers	2024–2028	Site assessment, planning & design Installation and commissioning	REREC	KES 44 M	National government through its various agencies.	11 secondary schools	New

Planned Electricity Transmission Projects by KETRACO

i. 220 kV Malindi–Weru–Kilifi

- Construction of approximately 49 km of 220 kV double circuit line from Weru to Kilifi with the establishment of a 220/132 kV, 2x90 MVA substation at New Kilifi and 220 kV bay extension at Weru substation.
- Construction of approximately 22 km of 220 kV double circuit line from Weru to Malindi with the establishment of a 220/33 kV, 45 MVA substation at Malindi and 220 kV bay extensions at Malindi and Weru substations.

N/B: KETRACO is considering changing this scope to the construction of a transmission line directly from New Kilifi to Malindi substation.

ii. 132/33 kV Mtwapa Substation off Rabai–Kilifi

- Construction of approximately 1.5 km Line-in-Line-Out (LILO) from Rabai to Kilifi and the establishment of a 2x45 MVA 132/33 kV substation at Mtwapa.

N/B: To be implemented by Kenya Power.

iii. 220 kV Mariakani-Dongo Kundu

Construction of approximately 58 km of 220 kV transmission line from Mariakani to the proposed 220/33 kV, 2x75 MVA Dongo Kundu Substation.

2. Access to Clean Cooking

Summary

Table 105: Projects and programmes to be implemented by the national government

S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
1.	To phase out traditional 3 stone open fire and metallic charcoal stoves while also stimulating uptake of LPG, bioethanol and biogas Electric cooking for urban households	Transitioning all households to cleaner cooking methods by 2028	2024–2028	Lobbying & creation of strategic partnerships, market activation, awareness creation & training workshops, demonstration & showcasing of technology, M&E	County directorate of Energy in collaboration with the national government, Development partners & the private sector	Market strengthening support (5,000,000) Capex for households' cost (KES 458,397,000 or KES 619,947,000) see table 67	County govt, National govt., Development partners, Private sector	All the 202,748 households using 3 stone open fire & charcoal metallic stoves	New
2.	To promote biogas uptake by households.	Promoting biogas uptake by livestock farmers in the county.	2024–2027	Partnerships and Resource Mobilization, Community Sensitization and Engagement, Technical Design and Procurement, Construction and Installation, Training and Capacity Building, Sustainability Planning, Knowledge Sharing and Replication	County department of energy in conjunction with the department of livestock	Capex—KES 2,899,500,000 Market activation—10,000,000.00	County government, national government, development partners and private sector	19,330 households	New

6.1.2 Projects and Programmes to be Implemented by County Government

1. Access to Electricity

Description

The goal of these projects is to ensure that the County achieves universal access to a reliable electricity supply for households, institutions, trading centers, MSMEs, and water supply for drinking by 2030. This will be achieved through a combination of the national electrical power grid, mini-grids, and distributed



standalone electrical systems. The County Government is allowed to carry out electricity reticulation and installation of street lighting.

- **Project 1:** Construction of a 140 km Electric Power Distribution system, ensuring universal access to electricity for households, health facilities, ECDEs, and County Vocational Technical Colleges.
- **Project 2:** Ensuring universal access to electricity in trading centres and markets.
- **Project 3:** Equipping drinking water supply systems (boreholes, water pans/earth dams, and KIMAWASCO) in the County with electrical power pumping infrastructure. The preference will be given to solar water pumping solutions.

Summary

Table 106: Summary of Projects and Programmes to be Implemented by Kilifi County Government

S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)- Inflation discounted cost	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
1.	To Construct 140 km of electric power distribution system and install back up plus solar water heater for health facilities Solar home systems for households and markets to increase productivity	Enhancing universal access to electricity in all learning centres	2024–2028	Site assessment, planning & design Installation and commissioning	County Government through energy directorate in consultation with Kenya Power and REREC	1 billion	National government & County Government	10,000 HHs 379 health facilities 10 County Vocational Training Colleges	New
2.	To connect markets to Solar PV systems for electrical supply	Enhancing universal access to electricity in all markets	2024–2028	Site assessment, planning & design Installation and commissioning Partnerships for productive use of energy	County Government of Kilifi	104 M	National government & County Government	26 markets	New
3.	To install street and public places lighting	Promoting 24/7 economy, enhancing security and safety.	2024–2028	Site assessment, planning & design Installation and commissioning	Energy directorate County Government of Kilifi	567.8 M	County Government		
4.	To repair and maintain of public lighting infrastructure	Public lighting infrastructure are well maintained.	2024–2028	Site visit, inspection and repair of the infrastructure	County Government of Kilifi	30 M	County government		

S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)- Inflation discounted cost	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
5.	To install 2 solar powered and 1 grid powered water pumping infrastructure at communal boreholes.	Equipping county water boreholes with water pumping infrastructure for domestic use.	2024–2028	Site assessment, planning & design Stakeholder engagement Pumping system installation and commissioning	County department of Water Access, backstopped by the county directorate of energy	KES 21.0 M	National government & County Government	3 boreholes	New
6.	General annual maintenance (a quarter of them)	Domestic water supply pumping infrastructure are well maintained.	2024–2028	Site visit, inspection and repair of the infrastructure	County department of Water Access, backstopped by the county directorate of energy	1.3 M	County Government	13 water pumping stations	
7.	To carry out Feasibility studies installing solar PV pump infrastructure in water pans	Viability of installing solar PV pump infrastructure in water pans	2024–2028	- Site visit assessment, & design	County department of Water Access, backstopped by the county directorate of energy	6.0 M	County Government	20 water pans	
8.	Installation of solar water pumping systems: Installation of solar Ice making machines for post-harvesting losses Solar for drying to reduce post harvest losses	Solar water pumping system installed	2024–2028	- Site assessment, planning & design - Pumping system installation and commissioning	County department of Water Access, backstopped by the county directorate of energy	224M	County Government	32 pumping water stations owned by KIMAWASCO	

2. Access to Clean Cooking

Description

- **Project 1:** Transitioning all 202,748 households to cleaner cooking methods by 2028. The project will entail spearheading households' uptake of cleaner cooking solutions comprising improved firewood and charcoal stoves, LPG gas, electricity, bioethanol, and biogas. The goal is to completely phase out the inefficient and wasteful traditional three-stone open fire and the metallic charcoal stoves by 2028 while also stimulating uptake of LPG, bioethanol, and biogas. Implementation will be led by the County Directorate of Energy working in collaboration with the national government, development partners, and the private sector.



- **Project 2:** Enhancing universal access to clean cooking solutions at primary, secondary, and colleges under the national government. The project will be implemented by MoEP in collaboration with the Ministry of Education and Kilifi County Directorate of Energy.
- **Project 3:** Enhancing universal access to clean cooking solutions at ECDEs and VTCs. The project will be implemented by the County Departments of ECDEs and VTCs with the County Directorate of Energy offering the necessary technical backstopping.
- **Project 4:** Displacing charcoal at level 4 hospitals. The project will be implemented by the County Departments of Health with the County Directorate of Energy offering the necessary technical backstopping.
- **Project 5:** Promoting clean cooking methods in the hospitality industry in the county. The project will be implemented by the County Department of Industry, Trade, and Tourism with support from the County Department of Energy.
- **Project 6:** Promoting biogas uptake by livestock farmers in Kilifi County. An ambitious biogas project targeting the households profiled as having potential to adopt the technology is proposed. The project will be led by the Energy Directorate with support from the Department of Livestock.

Summary

Table 107: Projects and Programmes to be Implemented by National Government

S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
1	To promote clean cooking methods at primary & secondary schools	Installation of improved stoves, bio-gas systems & modernization of kitchens	2024–2028	Partnerships and Resource Mobilization, Community Sensitization and Engagement, Technical Design and Procurement, Construction and Installation, Training and Capacity Building, Sustainability Planning, Knowledge Sharing and Replication	County govt in conjunction with other relevant stakeholders	1,831,950,000	County government & partners	Primary & secondary schools	New

Table 108: Projects and Programmes to be Implemented by County Government

S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
1.	To phase out traditional 3 stone open fire and metallic charcoal stoves while also stimulating uptake of LPG, bioethanol and biogas	Transitioning all households to cleaner cooking methods by 2028	2024–2028	Lobbying & creation of strategic partnerships, market activation, awareness creation & training workshops, demonstration & showcasing of technology, M&E	County directorate of Energy in collaboration with the national government, Development partners & the private sector	Market strengthening support (5,000,000) Capex for households' cost (KES 458,397,000 or KES 619,947,000) see table 67	County govt, National govt., Development partners, Private sector	All the 202,748 households using 3 stone open fire & charcoal metallic stoves	New
2.	To promote clean cooking methods at ECDEs and TVET institutions	Installation of improved stoves, biogas systems & modernization of kitchens	2024–2028	Partnerships and Resource Mobilization, Community Sensitization and Engagement, Technical Design and Procurement, Construction and Installation, Training and Capacity Building, Sustainability Planning, Knowledge Sharing and Replication	County govt in conjunction with other relevant stakeholders	4,844,750,000	County government & partners	ECDEs & TVET institutions	New
3.	To promote biogas uptake by households.	Promoting biogas uptake by livestock farmers in the county.	2024–2027	Partnerships and Resource Mobilization, Community Sensitization and Engagement, Technical Design and Procurement, Construction and Installation, Training and Capacity Building, Sustainability Planning, Knowledge Sharing and Replication	County department of energy in conjunction with the department of livestock	Capex—KES 555,600,000 Market activation—10,000,000.00	County government & partners	3,231 households	New



S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
4.	To displace 3 stone open stoves with more efficient ones.	Promoting clean cooking methods at the hospitality industry (eateries, restaurants & hotels) in the county.	2024–2028	Demonstration & product promotion events	County department of Trade, Industry and Tourism Access, back-stopped by the county directorate of energy	4,500,000 (capex cost)	County government & partners	Holding meetings in the seven sub-counties	New

6.1.3 Projects and Programmes to be Implemented by Development Partners and the Private Sector

Description

Note that the County Government is counting on support from development partners to implement all the above projects listed under the “County Government.” However, the projects listed below are those for which development partners and private sector players are expected to take a prominent role in implementation. The objectives, targets, timelines, costs, and beneficiaries are as listed under the above table on “Projects and Programmes to be Implemented by the County Government.”

- **Project 1:** Dissemination of clean cooking solutions and off-grid lighting solutions in households, SMEs, and institutions.
- **Project 2:** Promoting biogas uptake by livestock farmers and institutions in the county.
- **Project 3:** Market-based dissemination of solar-powered water pumps to farmers, with the objective of completely displacing fuel pumps or significantly reducing their usage.

6.2 Agro-Based Energy Programmes and Projects for Access to Electricity

6.2.1 Projects and Programmes to be Implemented by National Government

The National Government is responsible for implementing electricity access projects countrywide. These projects are implemented through Kenya Power, KETRACO, and the REREC. The National Government is also responsible for irrigation projects, namely Burangi, Kavunyalalo, and Sabaki, which are being upgraded in Kilifi County. Burangi irrigation is still under proposal; feasibility studies have been done for Kavunyalalo and Sabaki. Burangi is being implemented by the Coast Development Authority (CDA), while the other two are being implemented through the National Irrigation Authority (NIA) of Kenya.

Table 109: Proposed Irrigation Schemes by National Government

Project	Location	Acreage in Ha	Type	Status	Facility	Agency
Burangi Irrigation scheme	Near Burangi Primary	1,200 ha	New	Proposed	Weir	CDA (Coast development Authority)
Kavunyalalo Irrigation Scheme	Near Kavunyalalo Primary	8,240 ha	New	F/S	Weir	NIA
Sabaki Irrigation scheme	Near Sabaki Bridge	3,000 ha	Extension	F/S ongoing	Weir	NIA

Source: (Kilifi County Government, 2022)

6.2.2 Projects and Programmes to be Implemented by County Government

Description

- **Project 1:** Installation of solar water pumping systems on all viable irrigation schemes (boreholes, water pans, and rivers like Galana/Sabaki) across the county.
- **Project 2:** Connecting electrical power to crop agro-processing facilities (value addition).
- **Project 3:** Electrification of milk processing facilities.
- **Project 4:** Electrification of feed milling and mixing facilities.
- **Project 5:** Fishery cold storage facilities.



Summary

Table 110: Agro-Based Projects and Programmes to be Implemented by Kilifi County Government

S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)- Inflation discounted cost	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
1.	To develop three irrigation schemes	Burangi Irrigation scheme	2024–2028	Site assessment, planning & design Installation and commissioning	Coast devt agency (CDA) in collaboration of Kilifi County Government through Directorate of Agriculture and the county directorate of energy	xxx	Coast devt agency (CDA)	450 farmers living around Burangi in Kilifi county	New
		Kavunyalalo Irrigation scheme	2024–2028	Site assessment, planning & design Installation and commissioning	Coast devt agency (CDA) in collaboration of Kilifi County Government through Directorate of Agriculture and the county directorate of energy	xxx	National Irrigation Board of Kenya (NIB)	800 Farmers living around Kavunyalalo in Kilifi county	New
		Irrigation Sabaki Irrigation	2024–2028	Site assessment, planning & design Installation and commissioning	Coast devt agency (CDA) in collaboration of Kilifi County Government through Directorate of Agriculture and the county directorate of energy	xxx	County Government of Kilifi	Farmers living around Burangi in Kilifi county	New
2.	To install Solar PV Systems to viable irrigation schemes for eradication of extreme poverty and hunger by 2030	Electrification of all viable irrigation schemes	2024–2028	Site assessment, planning & design Installation and commissioning	Directorate of Agriculture backstopped by the county directorate of energy	1.684 B	County Government of Kilifi	11 (boreholes, water pans) spread across the county 1 solar mini-grid (20 kW) for 30 farmers in Kaloleni 4 and 8 solar mini-grid for 450 and 800 farmers respectively in Magarini and Malindi on River Sabaki	New

S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)- Inflation discounted cost	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
3.	To connect electrical Power crop Processing Facilities (Value Addition)	Installation of electrical power to all viable crop value addition facilities	2024–2028	Site assessment, planning & design Stakeholder engagement Pumping system installation and commissioning Training and Capacity Building	County directorate of Agriculture and Livestock development backstopped by the county directorate of energy	60M	County Government of Kilifi.	Kaloleni Cooperative Mwangaza Women Group in Rabai Maize processing and cassava processing public companies in Kilifi North sub-county	New
4.	To electrify all viable Milk processing facilities	Electrification of all viable milk processing facilities	2024–2028	Site assessment, planning & design Installation and commissioning	Directorate of Agriculture backstopped by the county directorate of energy	14.5 M	County Government of Kilifi.	installation a solar PV power systems to supplement the grid power. connect the unconnected to grid and Solar PV back system	
5.	To electrify all Feed Milling processing Facilities	Electrification of all viable irrigation schemes	2024–2028	Site assessment, planning & design Installation and commissioning	Directorate of Agriculture backstopped by the county directorate of energy	303.5 M	County Government of Kilifi.	4 facilities 3-phase Grid Connection 3 facilities single phase Grid Connection 12 facilities Installed solar PV system to off-grid to solar PV system and solar back up to those connected to the grid	
6.	To electrify all Fishery Cold Storage Facilities using Solar PV systems	Electrification of all viable irrigation schemes	2024–2028	Site assessment, planning & design Installation and commissioning Capacity enhancement for Beach management units	Directorate of Agriculture backstopped by the county directorate of energy	870 M	County Government of Kilifi.	Electrify all the existing 19 and the 15 proposed cold storage with 10 KW solar PV system, repair of the Solar PV system at Kuruwitu office and storage	New and existing



6.3 Energy Efficiency and Conservation Projects and Programmes

6.3.1 Projects and Programmes to be Implemented by County Government

The national government is responsible for the implementation of electricity access projects countrywide. These projects are executed through Kenya Power, the KETRACO, and the REREC.

- **Project 1:** Awareness creation and behavior change campaign to promote Energy Efficiency & Conservation in households. The project will be led by the Department of Communication, working in conjunction with the Department of Energy.
- **Project 2:** Reviewing County Building Codes and incorporating EE&C measures. The project will be implemented by the County Directorate of Public Works & Housing, supported by the County Department of Energy.
- **Project 3:** Promoting EE&C in designated industries by enforcing compliance with energy audit requirements. The project will be spearheaded by the Department of Energy, working in conjunction with the County Department of Trade and Industrialization.
- **Project 4:** Promoting EE&C in designated industries by enforcing compliance with energy audit requirements. The project will be spearheaded by the Department of Energy, working in conjunction with the County Department of Trade and Industrialization.
 - a) Supporting EPRA in enforcing energy audits in designated facilities. Begin by mapping potential ‘designated facilities’ in the counties.
 - b) Reviewing county building codes to embed EE&C measures.
 - c) Awareness creation on the most energy-efficient household appliances.



6.3.2 Summary

Table 111: Projects and Programmes to be Implemented by County Government

S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
1.	To implement an awareness and behavior change campaign in the county to disseminate information on EE&C practices and behaviors.	Awareness creation and behavior change campaign to promote Energy Efficiency & Conservation in households.	2024–2028	Development of applicable awareness creation content – anchored on MEPS regulations, Producing this content, Disseminating the content through talk shows, county energy days, social media awareness campaigns, public barazas, theatre/kits, school-based programmes, sporting events and publicity materials, Implementing an M&E framework for assessing outcomes.	County department of Communication, backstopped by the county directorate of energy	10M	County government & partners	Households	New
2.	To enhance energy efficiency and conservation practices in the construction sector by revising existing county building codes to incorporate EE&C standards and requirements.	Review of the County Building Codes and Incorporating EE&C Measures.	2024–2028	Review Existing Building Codes Stakeholder Consultation Development of EE&C Guidelines Capacity Building Public Awareness and Outreach Policy Advocacy	County directorate of Public Works & Housing	12M	County government & partners	The building sector	New
3.	To develop database on Energy consumption in buildings and industry	Collection of data on energy consumption in building and industry	2024–2028	Carry out interviews or administer a questionnaire to various energy consuming entities across the county	County directorate of energy	6 M	County government & partners	Energy planning unit at the county and national government	New



S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
4.	Energy assessment in public buildings	Carrying out a rapid energy efficiency assessment of the public building sector that identifies key opportunities and challenges, assesses stakeholders and resources, and determines priorities and next steps;	2024–2028	Assess energy technologies, sources, consumption and cost in public building sector	County directorate of energy	15M	County government & partners	County Government	New
5.	To build capacity of Key stakeholders	These include policy-makers in national and county government, academics, journalists, companies trading in energy products, Non-governmental Organizations, citizens, Civil Society Organizations, industry and trade associations and private sector actors to increase energy efficiency and conservation awareness.	2024–2028	Prepare information on energy efficiency, the national targets and the importance of EE&C	County directorate of energy	15M	County government & partners	County Government	New
6.	Install energy efficiency technologies in public buildings—such as county offices, schools, and hospitals—in order to lead by example;	Installation of energy efficiency technologies in public buildings—such as county offices, schools, and hospitals—in order to lead by example;	2024–2028	Installation of energy efficient equipment / machinery including steam boiler in county referral hospitals	County directorate of energy	100M	County government & partners	County Government	New
7.	To support installation of efficient kilns for charcoal production	Support charcoal producer association to install efficient kilns for charcoal production	2024–2028	Installation of efficient charcoal production kilns	County directorate of energy	10M	County government & partners	Charcoal producers and County Government	New



S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
8.	Carry out energy audit	Carry out energy audit in public institutions and industry	2024–2028	Contract energy auditors to audit at least 10 public institutions and industry	County directorate of energy	15 M	County government & partners	County Government	New
9.	Installation of smart energy efficient street lighting system	Install smart street lighting on at least 5 streets	2024–2028	Designing, contracting and installation of smart street at least 5 streets	County directorate of energy	60M	County government & partners	County Government	New
10.	To ensure designated facilities in the county are complying with the 4 year audit cycle requirement.	Promoting EE&C in designated industries by enforcing compliance of energy audit requirements.	2024–2028	Mapping all designated industries Enforcing compliance with energy audit requirement	County directorate of Energy	100M	County government & partners	The industrial sector	New

6.4 Bioenergy Resources Energy Programmes and Projects

6.4.1 Projects and Programmes to be Implemented by National Government

S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
1.	To enhance Policy, Regulatory and Institutional Frameworks for Effective Delivery and Coordination of Bioenergy Programmes.	Enhancement and harmonisation of policy, regulatory and institutional frameworks at the county government level	2024–2028	Reviewing policy, regulatory and institutional frameworks at the county government level	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	3 M	County government & partners	Stakeholders in bioenergy sector	New
		Forest management policies recognize and operationalize sustainable woodfuel production as one of the uses of forests and trees.	2024–2028	Operational forest management policies that support suitable woodfuel production as one of the products of forestry.	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	4 M	County government & partners	Stakeholders in bioenergy sector	New



S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
2.	Mobilizing Financial Resources for Local Bioenergy Development.	Funding secured from multilateral organizations, NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	2024–2028	Holding resources mobilization workshops with the financiers	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	10 M	County government & partners	Stakeholders in bioenergy sector	New
3.	Increase Substantially the Share of Sustainable Bioenergy in the County Energy Mix to 80% by 2030	Production of forest and non-forest biomass fuels;	2024–2028		Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	25 M	NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	Stakeholders in bioenergy sector	New
		Forest plantation development: This programme deals with development of commercial forest plantations to meet the growing needs of wood supply in the county. It contributes to re-stocking and sustainable management of all public plantations.	2024–2028		Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	25 M	County Government, multilateral organizations,	Stakeholders in bioenergy sector	New
		Further research is needed to determine the proper balance of residues (agricultural waste) that should remain in the field or in the forest to maintain soil fertility and soil carbon content, and improve soil conservation.	2024–2028		Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	3 M	NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	Stakeholders in bioenergy sector	New

S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
4.	Support and Facilitate Private Sector Involvement in Bioenergy Development	Market with low-interest loans for local bioenergy producers stimulated;	2024–2028	Making low interest loans available	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	500 M	NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	Stakeholders in bioenergy sector	New
		Standards and regulations for bioenergy technologies developed;	2024–2028	Develop standards and regulations	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	10 M	County Government, multilateral organizations,	Stakeholders in bioenergy sector	New
		Fiscal and investment incentives developed and implemented.	2024–2028	Dev't. of fiscal investment incentives	Kenya Forest Services, County directorate energy department of finance	10 M	County Government, multilateral organizations,	Stakeholders in bioenergy sector	New
5.	Installation of Domestic and Institutional Biogas Systems for Heating and Cooking	Installation of 8m ³ –12m ³ domestic Biogas Systems for Heating and Cooking	2024–2028	Feasibility studies, Design and installation of biogas plans	County directorate energy department of finance	530.1 M	NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	Households	New
		Installation of 12m ³ Institutional Biogas Systems for Heating and Cooking	2024–2028	Feasibility studies, Design and installation of biogas plans	County directorate energy department of finance, department of education	8.55 M	NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	Institutions (schools)	New



6.4.2 Projects and programmes to be Implemented by the County Government

Description

Summary

Table 112: Projects and programmes to be implemented by county government

S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
1.	To enhance Policy, Regulatory and Institutional Frameworks for Effective Delivery and Coordination of Bioenergy Programmes.	Enhancement and harmonisation of policy, regulatory and institutional frameworks at the county government level	2024–2028	Reviewing policy, regulatory and institutional frameworks at the county government level	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	3 M	County government & partners	Stakeholders in bioenergy sector	New
		County Bioenergy Committee (CBC) constituted	2024–2028	Identification of members, preparation of TOR for the committee Holding a meeting	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	0.5 M	County government & partners	Stakeholders in bioenergy sector	New
		Delivery and Coordination desk established at county government, and TORs developed and endorsed by all relevant stakeholders;	2024–2028	Provide the necessary facilities for the delivery and coordination desk	Directorate of energy	1 M	County government & partners	Stakeholders in bioenergy sector	New
		Collaboration Charter developed and endorsed by non-state actors and oversight provided by the CBC;	2024–2028	Devt. of collaboration charter	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	1 M	County government & partners	Stakeholders in bioenergy sector	New

S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
	(Continued) To enhance Policy, Regulatory and Institutional Frameworks for Effective Delivery and Coordination of Bioenergy Programmes.	Bioenergy industry associations strengthened; and	2024–2028	Provide Support to bioenergy industry associations to strengthen them	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	1 M	County government & partners	Stakeholders in bioenergy sector	New
		Bioenergy producers trained in sustainable bioenergy production practices.	2024–2028	Train the bioenergy producers on sustainable bioenergy production practices	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	2.1 M	County government & partners	Stakeholders in bioenergy sector	New
2.	Mobilizing Financial Resources for Local Bioenergy Development.	Funding secured from multilateral organizations, NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	2024–2028	Holding resources mobilization workshops with the financiers	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	10 M	County government & partners	Stakeholders in bioenergy sector	New
		Results-based financing that could enhance bioenergy enterprise economics deployed	2024–2028	Provide funds for result based financing	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	100 M	County Government, multilateral organizations, NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	Stakeholders in bioenergy sector	New



S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
3.	Mapping of the County's Bioenergy Resources with Potential for Bioenergy Development	GIS Inventory database of feasibilities studies for development various covering bioenergy feedstock resources established including active players in resource development	2024–2028	Develop A GIS inventory database of feasibility studies	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	5 M	County Government, multilateral organizations, NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	Stakeholders in bioenergy sector	New
		Biofuel production feasibility study	2024–2028	Carry out a feasibility study	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	3 M	County Government, multilateral organizations, NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	Stakeholders in bioenergy sector	New
		Feasibility study on sustainable woodfuel production	2024–2028	Carry out a feasibility study	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	3 M	County Government, multilateral organizations, NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	Stakeholders in bioenergy sector	New
		Feasibility study on production of briquettes for industrial heating	2024–2028	Carry out a feasibility study	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	3 M	County Government, multilateral organizations, NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	Stakeholders in bioenergy sector	New



S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
	(Continued) Mapping of the County's Bioenergy Resources with Potential for Bioenergy Development	Accurate forest-cover and land-use data made available.	2024– 2028	Carry out a study	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	5 M	County Government, multilateral organizations, NGOs, Foundations, banks, bilateral partners, donor agencies, NG- CDF, County Women Representative Fund to fund bioenergy activities	Stakeholders in bioenergy sector	New
4.	Increase Substantially the Share of Sustainable Bioenergy in the County Energy Mix to 80% by 2030	Sustainable bioenergy feedstock production promoted. On- farm growing of energy trees and crops, and fast-growing tree plantations established in public places by county governments and private sector, including peri- urban areas;	2024– 2028	Support growing of energy trees and crops	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	25	County Government, multilateral organizations,	Stakeholders in bioenergy sector	New
		Production of forest and non- forest biomass fuels;	2024– 2028		Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	25 M	NGOs, Foundations, banks, bilateral partners, donor agencies, NG- CDF, County Women Representative Fund to fund bioenergy activities	Stakeholders in bioenergy sector	New
		Under-served demands in selected industries for heat and power met by expanding the supply of biomass feedstocks.	2024– 2028		Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	10 M	County Government, multilateral organizations,	Stakeholders in bioenergy sector	New



S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
	(Continued) Increase Substantially the Share of Sustainable Bioenergy in the County Energy Mix to 80% by 2030	Farmland and dry land tree-planting initiative: This programme promotes tree planting outside public forest lands in order to contribute to the Realisation of 10% forest and tree cover by 2030.	2024–2028		Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	25 M	NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	Stakeholders in bioenergy sector	New
		Microforestry: Supporting, small farmers Collectively to carry out commercial tree growing	2024–2028		Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	25 M	NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	Stakeholders in bioenergy sector	New
		Agroforestry: integrating trees into agriculturally productive landscapes to provide a range of products and services to rural and urban people.	2024–2028		Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	10 M	County Government, multilateral organizations,	Stakeholders in bioenergy sector	New
		Further research is needed to determine the proper balance of residues (agricultural waste) that should remain in the field or in the forest to maintain soil fertility and soil carbon content, and improve soil conservation.	2024–2028		Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	3 M	NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	Stakeholders in bioenergy sector	New
5.	Support and Facilitate Private Sector Involvement in Bioenergy Development	Ease of doing business improved;	2024–2028		Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	10 M	County Government, multilateral organizations,	Stakeholders in bioenergy sector	New

S/No.	Objective	Project/ Programme	Timelines	Specific Activities	Implementing Agency	Project Cost (KES)	Source of fund	Targeted Beneficiaries	Status (New/ Ongoing)
	(Continued) Support and Facilitate Private Sector Involvement in Bioenergy Development	Private sector participation in bioenergy development strengthened;	2024–2028		Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	10 M	NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	Stakeholders in bioenergy sector	New
		Market with low-interest loans for local bioenergy producers stimulated;	2024–2028	Making low interest loans available	Kenya Forest Services, County directorate energy department of agriculture, department of Environment and natural resources	500 M	NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	Stakeholders in bioenergy sector	New
		Fiscal and investment incentives developed and implemented.	2024–2028	Devt. of fiscal investment incentives	Kenya Forest Services, County directorate energy department of finance	10 M	County Government, multilateral organizations,	Stakeholders in bioenergy sector	New
6	Installation of Domestic and Institutional Biogas Systems for Heating and Cooking	Installation of 8m ³ –12m ³ domestic Biogas Systems for Heating and Cooking	2024–2028	Feasibility studies, Design and installation of biogas plans	County directorate energy department of finance	530.1 M	NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	Households	New
		Installation of 12m ³ Institutional Biogas Systems for Heating and Cooking	2024–2028	Feasibility studies, Design and installation of biogas plans	County directorate energy department of finance, department of education	8.55 M	NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	Institutions (schools)	New



Chapter 7: IMPLEMENTATION, COORDINATION, MONITORING AND EVALUATION

7.1 Monitoring and Evaluation Framework

The basic components of Monitoring and Evaluation Frameworks include baseline indicators, theory of change, monitoring plan, evaluation plan, and a reporting plan. Preselected indicators and sources of data/information for the monitoring, evaluation, and reporting plans form part of this. The monitoring and evaluation process is applied across five groups of indicators: inputs, processes, outputs, outcomes, and impacts.

7.1.1 Monitoring Framework

Monitoring is a continuous function entailing systematic collection and analysis of data on the specified indicators to establish the extent of progress on the achievement of the Ministry's objectives and utilisation of the allocated funds. Monitoring reports will be prepared quarterly and annually to highlight the extent of progress against the set targets as well as document the challenges, recommendations, and lessons learnt. Directorates/Departments/Units will be required to develop annual work plans and budgets aligned to the Strategic Plan. They will also be expected to ensure their performance contract targets and performance appraisals are aligned to the work plans. The Ministry will develop a Monitoring and Evaluation Framework to guide monitoring in the sector.

7.1.2 Evaluation Framework

Evaluation will involve a systematic and objective process of assessing the level and extent of achievement of the strategic objectives and attainment of the strategic goals along the respective Key Result Areas (KRAs). The policies include their design, implementation, and results with regard to their relevance, efficiency, effectiveness, impact, and sustainability. This will provide an opportunity to ascertain if the interventions are coherent with the strategic objectives and implemented in an efficient manner. The Ministry will develop a Monitoring and Evaluation Framework to guide evaluation in the sector. The assessment will analyze the outcome indicators, targets, and baseline as summarised in the following tables.

7.1.3 Mid-Term Evaluation

The Directorate of Energy will conduct a mid-term evaluation of this Strategic Plan to examine the progress towards achieving the set targets and make modifications to ensure the set objectives are realized within the strategic plan period. This evaluation will be guided by the Kenya Evaluation Guidelines 2020 and the Kenya Norms and Standards for M&E.



7.1.4 End-Term Evaluation

The Directorate of Energy will conduct an end-term evaluation to take stock of the overall implementation of the Strategic Plan. This will assist in drawing conclusions, distilling lessons learned, and building a knowledge base to inform future planning and decision-making. This evaluation will be guided by the Kenya Evaluation Guidelines 2020 and the Kenya Norms and Standards for M&E.

7.1.5 Programmes and Projects to be Implemented by National Government

1. Electricity Access

Table 113: M&E Framework—Projects and Programmes for Implementation of Universal Access to Electricity by Households and Institutions

S/ no	Project/ Programme	Outcome indicators	Baseline		Annual targets				Total target by 2028	Data collection Responsibility	Reporting entity
			Value	Year	2024– 2025	2025– 2026	2026– 2027	2027– 2028			
1.	Facilitating Households' access to universal electricity in Kilifi County by 2030	No. of households connected to electricity	196,000	2023	30,216	30,216	30,216	30,216 2028– 2029 30,216 2029– 2030 30,216	181,285 HHs by 2030	Kenya Power/ County directorates of energy	County directorates of energy
2.	Enhancing universal access to electricity in all learning	No. of primary schools connected to grid/solar PV	542	2024	16	30	30	30	132 primary by 2028	County directorates of education	County directorates of energy
		No. of secondary schools connected to grid/solar PV	132	2024	5	6	0	0	11 second- ary by 2026	County directorates of education	County directorates of energy

7.2 Projects and Programmes to be Implemented by County Government

Table 114: M&E Framework—Projects and Programmes for Implementation of Universal Access to Electricity by Households and Institutions

S/ no	Project/ Pro- gramme	Outcome indicators	Baseline		Annual targets				Total target by 2028	Data collection Respon- sibility	Reporting entity
			Value	Year	2024– 2025	2025– 2026	2026– 2027	2027– 2028			
1	Facilitating Households access universal to electricity in Kilifi County by 2030	No. of households connected to electricity	196,000	2023	30,216	30,216	30,216	30,216 2028– 2029– 30,216 2029– 2030 30,216	181,285 HHs by 2030	Kenya Power/ County directorates of energy	County directorates of energy



S/ no	Project/ Pro- gramme	Outcome indicators	Baseline		Annual targets				Total target by 2028	Data collection Responsi- bility	Reporting entity
			Value	Year	2024– 2025	2025– 2026	2026– 2027	2027– 2028			
2	Enhancing universal access to electricity in all learning centers	No. of ECDEs connected to grid/Solar PV	249	2024	80	85	90	90	345 ECDEs by 2028	County directorates of education	County directorates of energy
		No of VTCs connected to 3-phase supply	43	2024	2	2	3	0	7 VTC by 2027	County directorates of education	County directorates of energy
		No of VTCs upgraded to 3-phase supply	3	2024	1	1	1	0	3 VTC by 2027	County directorates of education	County directorates of energy
3	Ensuring universal access to sustain- able & reliable electricity and water heating in health facilities	No. of Level 2 hospitals equipped with Solar water heating systems	0	2024	20	35	35	3	123 Level 2 by 2028	County department of health	County directorates of energy
		No. of Level 2 hospitals connected to grid/solar PV	114	2024	3	3	3	0	9 Level by 2 2028	County department of health	County directorates of energy
		No. of Level 2 hospitals equipped with grid comple- mentary diesel Genset/ PV systems	33	2024	10	19	19	19	67 Level 2 by 2028	County department of health	County directorates of energy
		No. of faulty PV systems rehabilitated at level 2 facilities	0	2024	6	6	6	7	25 Level 2 by 2028	County department of health	County directorates of energy
		No. of Level 3 hospitals upgraded from single phase to 3-phase	3	2024	2	3	4	4	13 Level 3 by 2028	County department of health	County directorates of energy
		No. of Level 3 hospitals equipped with Solar water heating systems	0	2024	2	4	5	5	16 Level 3 by 2028	County department of health	County directorates of energy
		No. of Level 4 hospitals equipped with grid comple- mentary diesel genset/PV systems	4	2024	2	2	0	0	4 Level 4 by 2028	County department of health	County directorates of energy
		No. of Level 4 hospitals connected to 3-phase supply	5	2024	2	2	2	2	3 Level 4 by 2028	County department of health	County directorates of energy
		No. of Level 4 hospitals equipped with Solar water heating systems	8	2024	2	2	2	2	8 Level 4 by 2028	County department of health	County directorates of energy
		No. of Level 5 hospitals equipped with Solar PV back up systems	1	2024	0	1	0	0	1 Level 5 by 2028	County department of health	County directorates of energy

S/ no	Project/ Pro- gramme	Outcome indicators	Baseline		Annual targets				Total target by 2028	Data collection Responsi- bility	Reporting entity
			Value	Year	2024– 2025	2025– 2026	2026– 2027	2027– 2028			
4	Ensuring universal Markets Electrification	No. of Markets connected to grid/Solar PV	37	2024	6	10	10	0	26 markets by 2028	County department of health	County directorate of energy
5	Street Lights and High Mast Floodlights in Public Places	Number of Grid connected street lamps installed per year	2,577	2024	90	300	300	300	990 street lamps by 2028	County department of health	County directorate of energy
		Number of Solar PV power street lamps installed per year	127	2024	50	100	150	150	450 markets by 2028	County department of health	County directorate of energy
		Number of Grid connected powered high mast floodlight installed per year	177	2024	1	2	2	2	7 markets by 2028	County department of health	County directorate of energy
		Number of Solar powered high mast floodlight installed per year	66	2024	10	15	20	20	65 markets by 2028	County department of health	County directorate of energy
6	Electrification of Water Pumps for Consumption Water	boreholes connected source of power	52	2024	1	2	0	0	3 boreholes by 2026	County department of health	County directorate of energy
		Feasibility study carried out to establish the viability of electrifying Communal Water Pans	20	2024	4	5	5	6	20 water pans by 2028	County department of health	County directorate of energy
		Solarization of KIMAWASCO water pumping by solar PV	2	2024	6	10	10	10	36 pumping stations by 2028	County department of health	County directorate of energy



2. Agro-Based Facilities

7.2.1.1 Projects and programmes to be implemented by National Government

Table 115: M&E framework—Projects and Programmes To be Implemented by National Government

S/ no	Project/ Programme	Outcome indicators	Baseline		Annual targets				Total target by 2028	Data collection Responsibility	Reporting entity
			Value	Year	2024– 2025	2025– 2026	2026– 2027	2027– 2028			
1	Burangi Irrigation scheme	Percentage of completion	0	2024	20%	70%	90%	100%	1	Coast Development Agency (CDA), National Irrigation Board (NIB) and Kilifi County Government	CDA and NIB and County department of Agriculture
2	Kavunyalalo Irrigation scheme	Percentage of completion	0	2024	20%	70%	90%	100%	1	County department of Agriculture and Energy	County department of Agriculture
3	Irrigation Sabaki Irrigation	Percentage of completion	0		20%	70%	90%	100%	1		

7.2.1.2 Projects and Programmes to be implemented by County Government

Table 116: M&E framework—Projects and programmes to be implemented by National Government

S/ no	Project/ Pro-gramme	Outcome indicators	Baseline		Annual targets				Total target by 2028	Data collection Respon- sibility	Reporting entity
			Value	Year	2024– 2025	2025– 2026	2026– 2027	2027– 2028			
1	Solar PV Electrification of Irrigation water pumping systems developed/ Rehabilitate	No. of Irrigation schemes development by National Government	0	2024	0	1	1	1	3 irrigation schemes developed 2028	Coast Development Agency (CDA), National Irrigation Board (NIB) and Kilifi County Government	CDA and NIB and County department of Agriculture
		No. of Irrigation schemes development by County Government	0	2024	6	6	6	6	24 irrigation schemes developed by 2028	County department of Agriculture and Energy	County department of Agriculture
2	To connect electrical Power crop Processing Facilities (Value Addition)	No. of viable crop value addition facilities electrified	0	2024	1	1	2	1	5 crop processing facilities electrified by 2028	County department of Agriculture and Energy	County department of Agriculture

S/ no	Project/ Pro- gramme	Outcome indicators	Baseline		Annual targets				Total target by 2028	Data collection Responsi- bility	Reporting entity
			Value	Year	2024– 2025	2025– 2026	2026– 2027	2027– 2028			
3	To electrify all viable Milk processing facilities		0	2024	1	1	1	0	3 milk pro- cessing facilities electrified by 2028	County department of Agriculture and Energy	County department of Agriculture
4	To electrify all Feed processing Facilities	No. of viable feed processing facilities electrified	0	2024	1	3	7	8	19 feed pro- cessing facilities electrified by 2028	County department of Agriculture and Energy	County department of Agriculture
5	To electrify all Fishery Cold Storage Facilities using Solar PV systems	Electrification of all viable irrigation schemes	0	2024	3	5	13	14	5 crop pro- cessing facilities electrified by 2028	County department of Agriculture and Energy	County department of Agriculture

7.3 Energy Efficiency and Conservation

7.3.1 Projects and programmes to be implemented by county government

Table 117: M&E framework—Projects and Programmes to be Implemented by National Government

S/ no	Project/ Programme	Outcome indicators	Baseline		Annual targets				Total target by 2028	Data collection Responsibility	Reporting entity
			Value	Year	2024– 2025	2025– 2026	2026– 2027	2027– 2028			
1	Awareness creation and behavior change campaign to promote Energy Efficiency & Conservation.	No. of sensitization carried out across all the sub-counties	0	2024	7	7	7	0	21	County depart- ment of Com- munication, backstopped by the county directorates of energy	County department of Commu- nication, back- stopped by the county directorates of energy
2	Review of the County Building Codes and Incorporating EE&C Measures. Collection of data on energy consumption in building and industry	No. of codes reviewed	0	2024	1	0	0	0	1	County department of Public Works & Housing	County directorates of energy



S/ no	Project/ Programme	Outcome indicators	Baseline		Annual targets				Total target by 2028	Data collection Responsibility	Reporting entity
			Value	Year	2024– 2025	2025– 2026	2026– 2027	2027– 2028			
3	Collection of data on energy consumption in building and industry	No. of sectors from which energy consumption data has been collected	0	2024	3	3	0	0	6	County department of Public Works & Housing	County directorate of energy
4	Carrying out a rapid energy efficiency assessment of the public building sector that identifies key opportunities and challenges, assesses stakeholders and resources, and determines priorities and next steps;	No. of public building sector assessed	0	2024	2	2	2	0	6	County directorate of energy and County department of Public Works & Housing	County directorate of energy
5	These include policy-makers in national and county government, academics, journalists, companies trading in energy products, Non-governmental Organizations, citizens, Civil Society Organizations,	No of training workshops for policy makers from building and Industry sectors held	0	2024	5	5	0	0	10	County directorate of energy	County directorate of energy
6	Installation of energy efficiency technologies in public buildings—such as county offices, schools, and hospitals—in order to lead by example;	No. of facilities installed with modern energy efficient technologies	0	2024	5	5	0	0	10	County directorate of energy	County directorate of energy



S/ no	Project/ Programme	Outcome indicators	Baseline		Annual targets				Total target by 2028	Data collection Responsibility	Reporting entity
			Value	Year	2024– 2025	2025– 2026	2026– 2027	2027– 2028			
7	Support charcoal producer association to install efficient kilns for charcoal production	No. of charcoal kiln installed	0	2024	5	5	0	0	10	County directorate of energy	County directorate of energy
8	Carry out energy audit in public institutions	No. of energy audit carried out in public building and industry	0	2024	5	5	0	0	10	County directorate of energy	County directorate of energy
9	Install smart street lighting on at least 5 streets	No. of streets installed with smart lighting	0	2024	2	2	2	2	10	County directorate of energy/Kilifi and Malindi Municipalities	County directorate of energy/Kilifi and Malindi Municipalities
10	Promoting EE&C in designated industries by enforcing compliance of energy audit requirements.	No. of industries compliant with energy audit requirements	0		2	2	2	2	8	County directorate of energy/Kilifi and Malindi Municipalities	County directorate of energy/Kilifi and Malindi Municipalities

7.4 Bioenergy Resources

7.4.1 Projects and programmes to be implemented by national government

Table 118: M&E Framework—Projects and Programmes to be Implemented by National Government

S/ no	Project/ Pro- gramme	Outcome indicators	Baseline		Annual targets				Total target by 2028	Data collection Responsi- bility	Reporting entity
			Value	Year	2024– 2025	2025– 2026	2026– 2027	2027– 2028			
1	Forest management policies recognize and operationalize sustainable woodfuel production as one of the uses of forests	Operationalisation of policy on sustainable woodfuel production as one of the uses of forests	0	2024	1	0	0	0	1	County directorate of energy	County directorate of energy



S/ no	Project/ Pro- gramme	Outcome indicators	Baseline		Annual targets				Total target by 2028	Data collection Responsi- bility	Reporting entity
			Value	Year	2024– 2025	2025– 2026	2026– 2027	2027– 2028			
2	Production of forest and non-forest biomass fuels;	No. of acreage under biomass fuel production	0	2024	100	300	300	300	1000	County directorate of energy	County directorate of energy
3	Further research is needed to determine the proper balance of residues (agricultural waste) that should remain in the field or in the forest to maintain soil fertility and soil carbon content, and improve soil conservation.	No of research studies	0	2024	1	0	0	0	1	County directorate of energy	County directorate of energy
4	Market with low-interest loans for local bioenergy producers stimulated;	Amount of loan borrowed	-	2024	100 M	100 M	100 M	100 M	500M	County directorate of energy	County directorate of energy
5	Fiscal and investment incentives developed and implemented.	Number of investment incentives developed	-	2024	1	0	0	0	0	County directorate of energy	County directorate of energy
6	Standards and regulations for bioenergy technologies developed;	No. of standards and regulations developed	-	2024	1	0	0	0	1	County directorate of energy	County directorate of energy
7	Installation of 8m ³ –12m ³ domestic Biogas Systems for Heating and Cooking	No. of biogas domestic installed	-	2024	534	1000	1000	1000	3534	County directorate of energy	County directorate of energy
8	Installation of 12m ³ Institutional Biogas Systems for Heating and Cooking	No. of biogas institutional installed	-	2024	2	4	6	7	19	County directorate of energy	County directorate of energy



7.4.2 Projects and programmes to be implemented by County government

Table 119: M&E framework—Projects and Programmes to be Implemented by National Government

S/ no	Project/ Programme	Outcome indicators	Baseline		Annual targets				Total target by 2028	Data collection Responsi- bility	Reporting entity
			Value	Year	2024– 2025	2025– 2026	2026– 2027	2027– 2028			
1	Funding secured from multilateral organizations, NGOs, Foundations, banks, bilateral partners, donor agencies, NG-CDF, County Women Representative Fund to fund bioenergy activities	Amount of money secured	0	2024	200M	500M	500M	357.4 M	1,557.4 M	County directorate of energy	County directorate of energy
2	Enhancement and harmonisation of policy, regulatory and institutional frameworks at the county government level	Enhanced and harmonised policy, regulatory and institutional framework	0	2024	0	1	0	0	1	County directorate of energy	County directorate of energy
3	Further research is needed to determine the proper balance of residues (agricultural waste) that should remain in the field or in the forest to maintain soil fertility and soil carbon content, and improve soil conservation.	No of research studies	0	2024	1	0	0	0	1	County directorate of energy	County directorate of energy
4	Installation of 8m ³ –12m ³ domestic Biogas Systems for Heating and Cooking	No. of biogas domestic installed	-	2024	534	1000	1000	1000	3534	County directorate of energy	County directorate of energy
5	Installation of 12m ³ Institutional Biogas Systems for Heating and Cooking	No. of biogas institutional installed	-	2024	2	4	6	7	19	County directorate of energy	County directorate of energy



7.5 Energy Efficiency and Conservations

7.5.1 Projects and programmes to be implemented by national government

Table 120: M&E framework—Projects and Programmes to be Implemented by National Government

S/ no	Project/ Pro- gramme	Outcome indicators	Baseline		Annual targets				Total target by 2028	Data collection Responsi- bility	Reporting entity
			Value	Year	2024– 2025	2025– 2026	2026– 2027	2027– 2028			
1	To phase out traditional 3 stone open fire and metallic charcoal stoves while also stimulating uptake of LPG, bioethanol and biogas	Transitioning all households to cleaner cooking methods by 2028	58454	2024	8615	16,802	84,338	225,692	393,901	Directorate of Kilifi County Government in collaboration with National Government	Directorate of Kilifi County Government
2	To promote biogas uptake by households.	Promoting biogas uptake by livestock farmers in the county.	303	2024	397	664	1,000	1,170	3,534	Directorate of Kilifi County Government in collaboration with National Government	Directorate of Kilifi County Government
3	To phase out three stone open fire stoves and to modernize the kitchens	Enhancing universal access to clean cooking solutions at Primary and secondary schools.	31	2024	147	194	166	173	711	MoEP in collaboration with Kilifi County Government, directorate of energy	County directorate of energy

7.5.2 Projects and programmes to be implemented by County government

Table 121: M&E framework—Projects and Programmes to be Implemented by National Government

S/ no	Project/ Pro- gramme	Outcome indicators	Baseline		Annual targets				Total target by 2028	Data collection Responsibility	Reporting entity
			Value	Year	2024– 2025	2025– 2026	2026– 2027	2027– 2028			
1	To phase out traditional 3 stone open fire and metallic charcoal stoves while also stimulating uptake of LPG, bioethanol and biogas	Transi- tioning all households to cleaner cooking methods by 2028	58454	2024	8615	16,802	84,338	225,692	393,901	Directorate of Kilifi County Government in collaboration with National Government	Directorate of Kilifi County Govern- ment
2	To promote biogas uptake by house-holds.	Promoting biogas uptake by livestock farmers in the county.	303	2024	397	664	1,000	1,170	3,534	Directorate of Kilifi County Government in collaboration with National Government	Directorate of Kilifi County Govern- ment
3	To phase out three stone open fire stoves and to modernize the kitchens	Enhancing universal access to clean cooking solutions at ECDEs and VTCs.	0	2024	111	269	180	515	999	County directorate of education	County directorate of energy
4	To displace 3 stone open stoves with more efficient ones.	Promoting clean cooking methods at the hospitality industry in the county.	64%	2024	68%	75%	85%	93%	100%	Hospitality industry collaboration with Kilifi County Government, directorate of trade tourism and industry and directorate of energy	County directorate of energy

N/B

The target for hospitality industry was given in % since it was a challenge to get the number of hospitality facilities in Kilifi County.



Chapter 8: CONCLUSIONS

This CEP represents a significant milestone in Kilifi County's journey towards achieving sustainable energy access and fostering inclusive development. Through comprehensive stakeholder engagement, rigorous data analysis, and strategic planning, the CEP has emerged as a dynamic and responsive framework tailored to the county's unique energy landscape. By identifying key challenges, proposing appropriate solutions, and fostering collaboration among diverse stakeholders, the CEP lays the foundation for transformative change, unlocking opportunities for economic growth, environmental sustainability, and improved livelihoods for all residents. Moving forward, the successful implementation of the CEP will require continued commitment, coordination, and innovation from all stakeholders as we work together towards a future powered by adequate, clean, reliable, and inclusive energy for generations to come.

It's acknowledged that not all the energy needs have been captured in this plan. This is on account of the dynamic and evolving nature of energy access challenges within the county. While the plan strives to comprehensively address existing gaps and barriers, it recognizes the possibility of emerging energy needs and unforeseen developments over time. However, this recognition does not signal defeat or inadequacy; rather, it signifies a proactive approach towards adaptability and continuous improvement. By incorporating a built-in mechanism for periodic review and evaluation, the CEP demonstrates a commitment to staying responsive and relevant in the face of changing circumstances. The scheduled review after three years offers a valuable opportunity to assess progress, identify new priorities, and incorporate lessons learned, ensuring that the energy plan remains effective, equitable, and reflective of the evolving needs and aspirations of the community. This iterative process not only enhances the resilience and flexibility of the CEP but also reinforces a culture of ongoing learning, innovation, and collaboration in addressing energy challenges.

Successfully implementing the plan hinges on the county government's ability to prioritize resource mobilization, recognizing the multifaceted nature of funding requirements and the diverse array of potential sources. Internal county departmental budgets represent a foundational source of funding, requiring strategic allocation and prioritisation to ensure sufficient financial support for energy initiatives outlined in the plan. Additionally, tapping into national government resources provides another avenue for funding, necessitating effective advocacy and collaboration with the national government to secure necessary allocations and grants. Development partners offer valuable financial and technical support, but accessing these resources requires proactive engagement, relationship-building, and alignment with partner objectives and priorities. Furthermore, leveraging private sector-led market-based interventions can unlock innovative financing mechanisms and attract investment capital, fostering sustainable energy solutions while stimulating economic growth. To effectively mobilize these resources, the county government must adopt a proactive approach, engaging in strategic lobbying efforts, forging partnerships, and networking with stakeholders across sectors. By leveraging a combination of internal budgetary allocations, strategic partnerships, and networking opportunities, the county government can harness the necessary resources to drive forward the implementation of the CEP, realizing its vision of sustainable energy access and inclusive development for all residents.



For coordinated implementation and in line with INEP requirements, the county government should expedite the operationalisation of the CEPC. The CEPC will be responsible for coordinating and overseeing CEP implementation. *The committee will be chaired by the County Executive Committee (CEC) member responsible for energy. The mandate of the CEPC will include:*

- Providing strategic leadership and governance oversight towards the Realisation of energy sector objectives.
- Deliberating and approving the recommendations submitted by the Technical Committee.
- Preparing the CEP for approval at the County Assembly.
- Setting out the county energy planning objectives and ensuring they are aligned with the national energy planning objectives.
- Reviewing periodic progress reports on the implementation of agreed targets in the CEP.
- Mobilizing resources, including allocation and distribution of mobilized resources.
- Promoting coordinated technical support and policy dialogue on strategic energy issues with national government, other county governments, development partners, Faith Based Organizations, Non-Governmental Organizations (NGOs), Civil Society, and private sector partners.
- Ensuring effective oversight through receiving and reviewing regular reports from the Technical Committee.

The membership of the CEPC shall constitute the following:



Table 122: Membership of the County Energy Planning Committee (CEPC)

No.	Organization	Position
1.	The CECM responsible for Energy	Chairperson
2.	Chief Officer responsible for energy	Member
3.	The Director responsible for Energy	Secretary
4.	One (1) representative of the County Commissioner	Member
5.	The CECM responsible for Finance and Planning	Member
6.	The Chief Officer responsible for Economic Planning	Member
7.	The CECM responsible for Lands, Housing, Physical Planning, and Urban Development	Member
8.	The CECM(s) responsible for Water, Environment, and Natural Resources	Member
9.	One (1) representative from KPLC	Member
10.	One (1) representative from REREC	Member
11.	One (1) representative from KFS County Representative	Member
12.	Technical County Officer(s) responsible for either Coal, Renewable Energy, and Electricity	Member
13.	A representative from a Non-Governmental Organization	Member
14.	A representative from the private sector	Member
15.	Not more than (5) Co-opted members from both State and Non-State Actors	Co-opted member

The necessity to bolster the manpower capacity within the Energy Directorate is paramount to the successful implementation of the CEP and the Realisation of its objectives. Presently, the Energy Directorate operates with limited human resources, comprising only one director overseeing the energy docket. This staffing configuration poses significant challenges in effectively executing the mandates and initiatives outlined in the CEP, particularly given the expansive scope of energy-related activities across the county. To address this shortfall, urgent measures are required to strengthen the organizational structure of this docket. Furthermore, there is an urgent need to augment the workforce by recruiting additional energy officers, ensuring adequate coverage and representation across all seven sub-counties: Kilifi South, Kilifi North, Rabai, Kaloleni, Ganze, Magarini, and Malindi. This decentralised staffing approach will facilitate closer engagement with local communities, enhance coordination, and streamline the implementation of energy projects and initiatives at the grassroots level.

Additionally, the development of a comprehensive policy framework is imperative to provide a robust regulatory foundation for anchoring the implementation of the CEP. This policy should delineate clear guidelines, mandates, and mechanisms for advancing energy access, promoting sustainability, and fostering innovation within the county.

Moreover, capacity-building initiatives are essential to equip officers within the energy department with the requisite skills, knowledge, and expertise in energy technologies (wind, solar, hydro, biogas, cookstoves, biomass, biofuels) and the use of GIS mapping in the development of energy interventions. By investing in human capital development, the county can build a cadre of skilled professionals capable of driving forward the ambitious agenda outlined in the CEP, ensuring its effective implementation and long-term success in advancing energy access and sustainability goals.

Finally, there are numerous opportunities in this document that the private sector can tap into, including the dissemination of SHS under the Least Cost Electrification Plan (LCEP), the dissemination of domestic and institutional clean cooking solutions, the installation of domestic and institutional biogas systems, the dissemination of solar water pumps to smallholder farmers, and the construction of sanitary landfills for LFGC, among many others. To this end, and in the coming days, the Department of Energy, in collaboration with the Department of Trade and other stakeholders, will prepare an energy investment prospectus that will showcase and elaborate these opportunities.



Chapter 9: REFERENCES

Alliance for an Energy Efficient Economy (AEEE) and Sustainable Energy for All (SEforALL) in Collaboration with the International Energy Agency. (March 2023). Strategic Plan for Advancing Energy Efficiency Across Demand Sectors and By 2030.

Buongiorno & Zhu. (2012). Calibrating and Updating the Global Forest Products Model (GFPM Version 2012). Staff Paper No. 77, Department of Forest and Wildlife Ecology, University of Wisconsin, Madison. p. 29.

County Government of Kilifi. (2018). County Integrated Development Plan 2018–2022.

County Government of Kilifi. (June 2020). Kilifi County GIS Energy Database.

County Government of Kilifi. (March 2024). Kilifi County GIS Energy Database.

FUTAO METAL. (2020, June 20). FUTAO Product Catalogue. Retrieved from FUTAO METAL: https://www.metalpole.org/?gclid=Cj0KCQjwnqH7BRDdARIsACTSAdtHebAusilgD2PV7F40zaZw38mOOxwXo4GSEVn-u3G6YmAH_3qGY8UaAhe3EALw_wcB

G.o.K, Ministry of Energy and Petroleum. (2019). Kenya Household Cooking Sector Study.

G.o.K, Ministry of Energy and Petroleum. (December 2015). Sustainable Energy for All Kenya Action Agenda.

GoK Ministry of Energy—Energy and Petroleum Regulatory Authority. (2012). Improved Biomass Cookstove Regulations, 2012 (draft).

GoK, Ministry of Energy and United Nations Development Programme. (September 2014). Documentation and Evaluation of the Efficacy of Households and Institutional Energy Cookstoves for Improved Livelihood and Poverty Reduction in Kenyan Communities.

Government of Kenya, KNBS. (2019). Kenya Population and Housing Census of 2019.

Government of Kenya, KNBS Census. (2019). 2019 Kenya Population and Housing Census IV.

Government of Kenya, MEW&NR. (2013). Analysis of Demand and Supply of Wood Products.

Government of Kenya, Ministry of Education. (2020). Basic Education Statistical Booklet.



Government of Kilifi County, Energy Department. (March 2023). Kilifi County GIS Energy Database.

GROOTS Kenya. (September 2019). Context Analysis on the Progress towards Improved Clean Cooking Energy at Household Level in Kilifi County.

International Energy Agency. (November 2019). African Energy Outlook. International Energy Agency.

International Energy Agency. (November 2022). World Energy Outlook 2022.

Kenya Agribusiness and Agroindustry Alliance. (2020, July 2). Challenges Faced by Small and Medium Enterprises in Kenya. Retrieved from Kenya Agribusiness and Agroindustry Alliance: <http://kaaa.co.ke/challenges-faced-by-small-and-medium-enterprises-in-kenya/>

Kenya National Bureau of Statistics. (2019). 2019 Kenya Population and Census: Volume II.

Kenya Power Annual Report. (June 2018). Annual Report and Financial Statements for the Financial Year Ended 30th June 2018.

Kenya Power. (June 2023). Annual Report and Financial Statement for the Year Ended 30th June 2023.

Kenya Prisons Service (Headquarters). (September 2018). Types of Cooking Solutions Used in Prisons.

KIARIE, N. (2016, September 15). How the counties fare on forest cover as Kenya strives for elusive target. Retrieved November 07, 2019, from Business Daily: <https://www.businessdailyafrica.com/news/How-the-counties-fare-on-forest-cover-as-Kenya/539546-3381286-6deeeo/index.html>

Kilifi County—SETA Team. (March 2023). Kilifi County Household Energy Access Survey Report.

Kilifi County Education Office—Ministry of Education. (March 2024). Electrification Status of the Public Secondary Schools in Kilifi County.

Kilifi County Government. (2013). County Integrated Development Plan 2013–2017.

Kilifi County Government. (2018). County Integrated Development Plan 2018–2022.

Kilifi County Government. (2020, March 20). About Us. Retrieved from Kilifi County Government: <https://www.kilifi.go.ke>

Kilifi County Government. (2022). Kilifi County Spatial Plan 2021–2030.

Kilifi County Government. (May 2023). County Integrated Development Plan 2023–2027.



Kilifi County Government, Department of Energy. (March 2020). Feasibility Study for the Adoption of Domestic Biogas System in Kilifi County.

Kilifi County Government, Directorate of Energy. (October 2019). Feasibility Study of Waste to Energy.

Kilifi County Government—SETA Team. (June 2023). Analysis of Energy Access Data for Institutions in Kilifi County.

Kilifi County Govt and GROOTS Kenya. (December 2019). Context Analysis on the Progress Towards Improved Clean Cooking Energy at Household Level in Kilifi County.

Kituyi, E., & al, e. (2001, February). Biofuel Consumption Rates and Patterns in Kenya. Retrieved February 15, 2020, from ResearchGate: https://www.researchgate.net/publication/232407253_Biofuel_consumption_rates_and_patterns_in_Kenya

MINES ParisTech and Vaisala. (2018, April 24). Kenya—Solar, Wind and Transmission Infrastructure. Retrieved from Global Atlas for Renewable Energy: <https://irena.masdar.ac.ae/gallery/#gallery>

Ministry of Energy, Government of Kenya. (2015). Kenya SE4All Action Agenda 2015.

Ministry of Environment, Water and Natural Resources. (July 2013). Analysis of Demand and Supply of Wood Products in Kenya.

Mugo, F., and Gathui, T. of Practical Action. (October 2010). Biomass energy use in Kenya. A background paper prepared for the International Institute for Environment and Development (IIED) for an international ESPA workshop on biomass energy, 19–21.

REREC, Ministry of Energy and Petroleum. (2014). Guidelines for Biogas Generation (Draft).

SNV Kenya, Netherlands Enterprise Agency, and Clean Cookstoves Association of Kenya. (August 2018). Study on Use of Biomass Cookstoves and Fuels in Kenya.



Chapter 10:ANNEXES

Existing/proposed/communal/on-farm

There are 52 communal boreholes in Kilifi County, of which 2 are on-grid while the remaining 50 are off-grid. Three of the off-grid boreholes require solar-powered pumps.

Name	Sub-County	Ward	In Need of Pumping Solution?	Grid /Transformer Proximity	Capacity (Liters)	Daily Water Demand or Supply (Liters)
Kibarani	Kilifi North	Kibarani	Yes			
Kadzandani	Magharini	Adu	No	On -grid	100,000	200,000
Kambicha	Magharini	Adu	No	On -grid	300,000	500,000
Makumba	Magharini	Garashi		Off-grid	N/A	N/A
Kwa Upanga	Malindi	Ganda	Yes	Off-grid		

Water pans Communal/on farm in need of pumping solution Off-grid

There are 20 water pans in Kilifi county owned by the community.that requires water pumping solution.

Name	Sub-County	Ward		Capacity (Liters)	Daily Water Demand or Supply (Liters)
Jongooni	Ganze	Jaribuni	Communal	10,000	20,000
Jeshi	Ganze	Bamba	Communal	10,000	20,000
Bamba	Ganze	Bamba	Communal	10,000	20,000
Mrima Wa Ndege	Ganze	Jaribuni	Communal	10,000	20,000
Bamba Catholic	Ganze	Bamba	Communal	10,000	20,000
Kwa Gona B	Ganze	Bamba	Communal	10,000	20,000
Kwa Msuko Water Pan	Ganze	Jaribuni	Communal	10,000	20,000
Lafithi	Magharini	Marafa	Communal	7,500	20,000
Magarini	Magharini	Magarini	Communal	7,500	20,000
Chalalu	Magharini	Marafa	Communal	10,000	20,000
Tabgini	Magharini	Marafa	Communal	5,000	20,000
Mizaheni	Kaloleni	Mwanamwinga	Communal	-	-
Makwanje	Kaloleni	Mwanamwinga	Communal	-	-
Muungano	Kaloleni	Kaloleni	Communal	-	-
Kasidi	Rabai	Ruruma	Communal	-	-
Mleji	Rabai	Ruruma	Communal	-	-
Lutsanga	Rabai	Kambe Ribe	Communal	-	-
Chitsaka Cha Bahasi	Rabai	Rabai Kisurutini	Communal	-	-
Mikomani Kwa Diki	Rabai	Ruruma	Communal	-	-
Mwamunga	Rabai	Ruruma	Communal	-	-



Milk Processing Centres

Center Name	Location	Source of power	Existing/proposed	Public/private/communal	Back up Energy (e.g grid, solar etc)	Average monthly cost of Power (main +back up)	Remarks
Rabai milk collection and cooling center	Batani, Ruruma ward	Electricity	Existing	Communal	None		Not yet operating
Bamba dairy	Bamba	Electricity	Existing	Communal	N/A		The collection centre closed: Rent, Drought.
Ganze milk collection and cooling center	Ganze	Electricity	Existing	Public	N/A		Not in use. Fault/rusty milk tank
Magarini Dairy Farmer Cooperative Society	Gongoni before Gongoni Health Centre from the Gongoni stage	Electricity	Existing-500litres/ Proposed-1500Ltrs /Day	Public	Solar	15,000	A cost-effective energy source is a requirement to sustain the production/production.
Malindi product limited	Ganda	Electricity	Existing—2000 litres	Private	GRID	260000	Cheese production
Amani Chonyi Dairy	Mwembe Kati.	Electricity	Existing	Communal	Electricity/Solar	2000	Good Condition
Zowerani	Tezo	Electricity		On going	—		Active
Manyeso dairy	Watamu	Electricity		Communal	—	900 WTS	Dormant
Umoja youth group	Kibarani		Existing	Communal	—		
Ubora dairy	Tezo		Existing	Communal	—		

Feed Processing (Milling and Mixing)

Center Name	Location	Public/private/communal	Grid / transformer proximity	Power adequacy	Back up Energy (e.g grid, solar etc)	Existing/proposed load (W)	Remarks
Miyuni Dairy dairy	Kasidi village (Ruruma ward)	Communal	>600m	Not connected	Diesel powered		It's new but not yet operating
Mwangaza women group	Mwanzagu village (Rabai Kisurutini ward)	Communal	<600m	Not connected	None		New but not yet operating,
Chauringo / Makobeni SHG	Chauringo (Kambe/Ribe ward)	Communal	<600m	Not connected	None	240V	New but not yet operating
Tupendane SHG	Making (Kambe/Ribe ward)	Communal	<600m	Not connected	None	240V	New but not yet operating
Wajibika SHG	Mbwaka (Kambe/Ribe ward)	Communal	<600m	Not connected	None	240V	New but not yet operating
Glory SHG	Mbararani village	Communal	Off-grid			240V	New
Miyuni Dairy dairy	Kasidi village (Ruruma ward)	Communal	>600m	Not connected	Diesel powered		It's new but not yet operating

Center Name	Location	Public/ private/ communal	Grid / transformer proximity	Power adequacy	Back up Energy (e.g grid, solar etc)	Existing/ proposed load (W)	Remarks
Magarini ni Poultry farmers coop	Gongoni Town next to PEFA Church	Public	<600	Connected	Solar but not installed	200watts	Incomplete. Need for a cost- effective energy source as either back or fulltime.
Gotani (pangayambo)	Kayafungo	Communal	<600m	Connected	None	240	Functioning (needs bearing replacement)
Safina Bundacho Kuku Kienyeji.	Chasimba	Communal	>600	N/A	N/A	240 watts	Still new
Riziki Women Group	Mtwapa	Communal	<600m	Connected	None	240 watts	Good Condition
Malindi product limited	Ganda	Private	<600	Connected	GRID		Cheese production
Tumaini WG	Matsangoni	Communal			–	800 wtts	

KIMAWASCO Water Pumping Stations

Existing/ proposed	Source of pumping power	Grid/ transformer proximity (see the codes)	Head in m (Elevation)	Pump capacity (kW)
Managed by KIMAWASCO				
Chasimba Mbomboni pump station	KPLC	<600m	228	30
Jaribuni Pump	KPLC/Solar	<600m		22
Kitsoeni pump	KPLC	<600m	166	22, 45
Silala Pump Station	KPLC	<600m	154	10
Tsalu pump station chonyi	Diesel	>600m	186	
Kachako pump station	KPLC	<600m		22
Baricho Pump Station	KPLC	<600m		
Ganze Pump station	KPLC/Diesel	<600m		18.5x4no.
Dungicha pump station	Diesel	>600m		
Mweza Pump station(Bahero)	KPLC	<600m		37
Muyuni Pump station	Solar	>600m		
Mulungu wa Mawe Pump station	KPLC/Solar/Diesel-Genset	<600m		18.5x4no.
Palakumi pump station	Diesel-Genset	>600m	247	22
Hademu pump station	KPLC	<600m	275	22
Chinyume Pump	KPLC	<600m	227	45
Kitsaumbi Pump	KPLC	<600m		
Lower Ribe-171M Pump	KPLC	<600m		45, 30
Mkapuni Pump Station	KPLC	<600m		
Upper Ribe-225M	KPLC	<600m		45
Nyari-Danicha Pump station	KPLC	<600m		11
Muongano Konjora Pump	KPLC	<600m		11



Existing/ proposed	Source of pumping power	Grid/ transformer proximity (see the codes)	Head in m (Elevation)	Pump capacity (kW)
Damview Pump	KPLC	<600m		30, 37
Kaptuku Pump Station	Diesel	<600m		
Kibao Kiche Pump Station	Diesel	<600m		
Mariakani Township Pump	KPLC	<600m		18, 18
Mwavumbo pump house	KPLC	<600m	181	37x2no.,55x2no
Barracks Pump Station (The Hague)	KPLC	<600m		
Kokotoni Pump Station	KPLC	<600m		
Mazeras Pump Station	KPLC	<600m		132, 55
Mapawa Pump	Diesel	>600m		
Ubaoni Pump	Diesel	>600m		
Kang'amboni-Mwahera Pump station	Diesel	>600m	177	
Kwa Mwambire Pump station	KPLC	<600m		
Milore pump station (1)	Solar	>600m		7.5
Milore pump station (2)	Solar	>600m		7.5
Mrima wa Ndege pump station	Diesel	>600m		24HP
Managed by Community				
Ziani Pump Station (Community P)	KPLC	<600m		
Rojo pump house*		<600m	46	

Unelectrified Public Mixed Day Primary School

Name	Type of School	Location	Status
Chalani Primary	Ordinary	Kaloleni	Not Electrified
Chilulu Primary	Ordinary	Jibana	Not Electrified
Chilulu Special Unit	Special School	Jibana	Not Electrified
Ikanga Primary	Ordinary	Mwanamwinga	Not Electrified
Kakomani Primary	Ordinary	Mwanamwinga	Not Electrified
Mgamboni Primary	Ordinary	Jibana	Not Electrified
Mikiriani Primary	Ordinary	Kaloleni	Not Electrified
Walea Primary	Integrated	Kaloleni	Not Electrified
Walea Unit For The Mentally Handicap	Special School	Kaloleni	Not Electrified
Gahaleni Primary	Ordinary	Malindi	Not Electrified
Gandini Primary	Ordinary	Langobaya	Not Electrified
Kavunyalalo Primary	Ordinary	Goshi	Not Electrified
St Andrews Primary	Ordinary	Malindi	Not Electrified
Timboni Primary	Ordinary	Langobaya	Not Electrified
Buni Primary	Ordinary	Rabai	Not Electrified
Kaliang'ombe Primary	Ordinary	Rabai	Not Electrified

Name	Type of School	Location	Status
Mwatsama Primary	Ordinary	Rabai	Not Electrified
Crs Primary	Ordinary	Gede	Not Electrified
Marafiki Primary	Ordinary	Matsangoni	Not Electrified
Mdzongoloni Primary	Ordinary	Tezo	Not Electrified
Mkombe Primary	Ordinary	Ngerenya	Not Electrified
Mwakuhenga Primary	Ordinary	Takaungu Mavueni	Not Electrified
Ngerenya Primary	Ordinary	Ngerenya	Not Electrified
Baharini Primary	Ordinary	Mtwapa	Not Electrified
Chasimba Primary	Ordinary	Chasimba	Not Electrified
Dindiri Primary	Ordinary	Chasimba	Not Electrified
Kireme Primary	Ordinary	Junju	Not Electrified
Mapawa Primary	Ordinary	Junju	Not Electrified
Bale Primary	Ordinary	Sokoke	Not Electrified
Baraka Primary			Not Electrified
Danicha Primary	Ordinary	Sokoke	Not Electrified
Goshi Primary	Ordinary	Mitangani	Not Electrified
Jira Primary	Ordinary	Mitangani	Not Electrified
Kahingoni Primary	Ordinary	Sokoke	Not Electrified
Kanjaocha Primary	Ordinary	Mitangani	Not Electrified
Madamani Primary	Ordinary	Vitengeni	Not Electrified
Mangudho Primary	Ordinary	Sokoke	Not Electrified
Mbunga Primary			Not Electrified
Midoina Primary	Ordinary	Mitangani	Not Electrified
Mirihini Primary	Ordinary	Ndigiria	Not Electrified
Munago Wa Dola Primary	Ordinary	Mitangani	Not Electrified
Mwahera Primary	Ordinary	Mwahera	Not Electrified
Mwakwala Primary	Ordinary	Bamba	Not Electrified
Mwangea Primary	Ordinary	Mwahera	Not Electrified
Ndugumnani Primary	Ordinary	Mwahera	Not Electrified
Nzovuni Primary	Ordinary	Bamba	Not Electrified
Oliviera Primary			Not Electrified
Rare Primary	Ordinary	Sokoke	Not Electrified
Tsanzuni Primary	Ordinary	Palakumi	Not Electrified
Vitsapuni Primary	Ordinary	Palakumi	Not Electrified
Yembe Primary	Ordinary	Langobaya	Not Electrified
Baharini Primary	Ordinary	Magarini	Not Electrified
Balaga Primary			Not Electrified
Baraka Jembe Primary			Not Electrified



Name	Type of School	Location	Status
Baricho Primary	Ordinary	Bungale	Not Electrified
Boresingwaya Primary	Ordinary	Garashi	Not Electrified
Boresingwaya Primary			Not Electrified
Boyani Primary	Ordinary	Gongoni	Not Electrified
Bungale Primary	Ordinary	Bungale	Not Electrified
Bura Primary	Ordinary	Dagamra	Not Electrified
Chakama Primary	Ordinary	Chakama	Not Electrified
Dakacha Primary	Ordinary	Bungale	Not Electrified
Galana-Primary			Not Electrified
Garihe Primary	Ordinary	Gongoni	Not Electrified
Hawewanje Primary	Ordinary	Chakama	Not Electrified
Kalimboni Primary			Not Electrified
Kamale Primary	Ordinary	Adu	Not Electrified
Kanyumbuni Primary	Ordinary	Marafa	Not Electrified
Karimboni Primary	Ordinary	Dagamra	Not Electrified
Kasgini Primary			Not Electrified
Kayadagamra Primary	Ordinary	Dagamra	Not Electrified
Kulalu Primary	Ordinary	Chakama	Not Electrified
Majahazini Primary	Ordinary	Magarini	Not Electrified
Makumba Primary	Ordinary	Marafa	Not Electrified
Malolani Primary			Not Electrified
Matolani Primary	Ordinary	Chakama	Not Electrified
Mbaoni Primary			Not Electrified
Mtsangamali Primary	Ordinary	Fundisa	Not Electrified
Mugumoni Primary	Ordinary	Dagamra	Not Electrified
Mulunguni Primary	Ordinary	Bungale	Not Electrified
Mwangatini Primary	Ordinary	Magarini	Not Electrified
Mwangatini Primary			Not Electrified
Ndololo Primary			Not Electrified
P C E A Bombi Primary	Ordinary	Chakama	Not Electrified
Progressive School Kagombani			Not Electrified
Pumwani Primary	Ordinary	Magarini	Not Electrified
Shakahola Primary	Ordinary	Chakama	Not Electrified
Singwaya Primary	Ordinary	Garashi	Not Electrified
Soso Chamari Primary	Ordinary	Marafa	Not Electrified
Sosoni Primary	Ordinary	Gongoni	Not Electrified
Ulaya Feeder Primary	Ordinary	Bungale	Not Electrified
Vithunguni Primary			Not Electrified



Name	Type of School	Location	Status
Waresa Primary	Ordinary	Marafa	Not Electrified
Watala Primary	Ordinary	Marafa	Not Electrified
Yedhi Primary	Ordinary	Fundisa	Not Electrified

Unelectrified VTC

Name	Primary fuel	Secondary fuel	Type of kitchen (modern/ temporary)	Average student population	Electrification Status
Kibarani Vocational Training	Firewood	charcoal	Temporary		Not Electrified
Viriko Village Polytechnic	Firewood	charcoal	Temporary		Not Electrified
Mwaeba	Firewood	charcoal	Temporary	62	Not Electrified
Kambi Ya Waya	Firewood	charcoal	Temporary	154	Not Electrified
Shakahola	Firewood	charcoal	Temporary	123	Not Electrified
Bungale	Firewood	charcoal	Temporary	182	Not Electrified
Tsangatsini	Firewood	charcoal	Temporary	61	Not Electrified
Hademu	Firewood	charcoal	Temporary	26	Not Electrified
Mwanamwinga	Firewood	charcoal	Temporary	8	Not Electrified
Tsagwa	Firewood	charcoal	Temporary	80	Not Electrified
Ganze	Firewood	charcoal	Temporary	41	Not Electrified
Palakumi	Firewood	charcoal	Temporary	71	Not Electrified
Bamba	Firewood	charcoal	Temporary	183	Not Electrified
Kaya Dagamra	Firewood	N/A	N/A	0	Not Electrified
Kaoyeni	Firewood	charcoal	Temporary	130	Not Electrified
Mwele Simakeni	N/A	N/A	Temporary	0	Not Electrified
Junju	N/A	N/A	Temporary	0	Not Electrified
Matandale	N/A	N/A	Temporary	0	Not Electrified
Karimboni	Firewood	charcoal	Temporary	187	Not Electrified

KOSAP COMPONENT 3A—KPLC STAND-ALONE SOLAR SYSTEMS FOR COMMUNITY FACILITIES

All the facilities are not electrified apart from Bwagamoyo which is electrified but the power is not stable

No.	Name	Approximate Distance from the Grid (km)	Type of equipment
Kaloleni Sub-County			
1	Viragoni dispensary	>15km	Freezers, Autoclaves, Fridges, Computers, Lights and Heaters.
Kilifi North Sub County			
2	Kadaina Dispensary	>15km	Freezers, Autoclaves, Fridges, Computers, Lights and Heaters.



No.	Name	Approximate Distance from the Grid (km)	Type of equipment
Rabai Sub-County			
3	Bwagamoyo Secondary School	Less Than 15km	Computers (Lab), Phones, Lights and Heaters
Ganze Sub County			
	Muryachakwe Dispensary	>15km	Freezers, Autoclaves, Fridges, Computers, Lights and Heaters.
	Midoina dispensary	>15km	Freezers, Autoclaves, Fridges, Computers, Lights and Heaters.
Magarini Sub County			
	Kurawa Secondary School	>15km	Computers(Lab),Phones, Lights and Heaters
	Watala Secondary School	>15km	Computers(Lab), Phones, Lights and Heaters
	Mwangatini Dispensary	>15km	Freezers, Autoclaves, Fridges, Computers, Lights and Heaters.
	Baricho Secondary School	2.3km	Computers(Lab),Phones, Lights and Heaters
	Gandini Assistant Chief's office	>15km	Not Given Due to short period data required
	Gandini Primary School	>15km	Computers(Lab),Phones,Lights and Heaters
	Gandini dispensary	>15km	Freezers, Autoclaves, Fridges, Computers, Lights and Heaters.
	Karimboni dispensary	>15km	Freezers, Autoclaves, Fridges, Computers, Lights and Heaters.
	Mulunguni dispensary	>15km	Freezers, Autoclaves, Fridges, Computers, Lights and Heaters.
	Motoloani dispensary	>15km	Freezers,Autoclaves,Fridges,Computers,Lights and Heaters.
	Shujaa Mekatilili Secondary	>15km	Computers(Lab),Phones,Lights and Heaters
	Local Chief's Office	>15km	Lights,computers and heaters
	Waresa Secondary School	>15km	Computers(Lab),Phones,Lights and Heaters
	Chamari dispensary	>15km	Freezers,Autoclaves,Fridges,Computers,Lights and Heaters.

Component 1: Mini-grids for Households and Public Facilities

As the target counties are not served by the national grid, mini-grids will be constructed to be the main source of energy. A total of 151 mini-grids will be constructed in 12 of the 14 Counties. The mini-grids will then be used to provide electricity to community facilities, enterprises and households. The mini-grids will be constructed in areas that have a population of 100 households and sufficient existing or potential business and institutional load.

Mini-Grid Project Sites in Kilifi County

- Bombi
- Chakama
- Kirepwe

Component 2: Stand Alone Solar Home Systems

The vast majority of off-grid population in the 14 counties is dispersed and requires individual system solutions (Solar Home Systems—SHS). Under this component the Project aims to establish sustainable supply chains for marketing and sales of SHS in KOSAP Counties. While the Private Sector Actors have

penetrated the solar market in other parts of the country they have not made the same in-roads in the 14 Counties. The Project has established a Results-Based Financing (RBF) and Debt Facility which will provide incentives to solar businesses to extend and expand their reach in the 14 Counties.

Under this component the project aims to deliver 250,000 Stand-alone Solar home Systems and 150,000 high-tier clean cooking solutions. SNV Netherlands Development Organisation in partnership with SunFunder are the Facilities Manager.

Types of Support under the RBF and Debt Facilities

There are three Facilities available for access by private companies:

1. Solar Service Providers Results-Based Financing (SSP RBF) Facility (KES 1.2 billion) for Solar Service Providers
2. Debt Facility (KES 3 billion) for Solar Service Providers
3. Challenge Fund and RBF Facility (KES 0.5 billion) for Clean Cooking Solutions Service Providers (CCS SPs)

For further information on these Facilities and application process, please visit www.kosap-fm.org.

For the list of ECDES, and primary schools, and their cooking energy status—please consult the Kilifi GIS office for the full list.

Secondary schools & cooking energy status

Sub-county	Name	Day & Boarding	Primary stove	Average student population
Ganze	Dungicha Secondary	Day	Not improved	308
Ganze	Ganze Boys Secondary	Boarding	Not improved	527
Ganze	Ganze Girls Secondary	Boarding	Not improved	741
Ganze	Godoma Secondary	Day & Boarding	Not improved	738
Ganze	Jaribuni Secondary	Day & Boarding	Not improved	678
Ganze	Kachororoni Secondary	Day	Not improved	630
Ganze	Magogoni Secondary	Day	Not improved	194
Ganze	Amason Kingi Secondary	Day	Not improved	272
Ganze	Ambassador Kithi Secondary	Day	Not improved	80
Ganze	Midoina Secondary	Day	Not improved	93
Ganze	Mwangea Girls Secondary	Day Only & Boarding	Not improved	567
Ganze	Palakumi Secondary	Day	Not improved	471
Ganze	Petanguo Secondary	Day	Not improved	241
Ganze	Bale Secondary	Day	Not improved	552
Ganze	Vitengeni Baptist Secondary	Day & Boarding	Not improved	791



Sub-county	Name	Day & Boarding	Primary stove	Average student population
Ganze	Jila Secondary	Day	Not improved	335
Ganze	Sokoke Secondary	boarding	Not improved	456
Ganze	Bandary Secondary	Day & Boarding	Not improved	509
Ganze	Shaka Secondary	Day_or_Boa	Not improved	386
Ganze	Mitangani Secondary	Day	Not improved	1240
Ganze	Shangweni Secondary	Day	Not improved	138
Ganze	Ndugu Mnani Secondary	Day	Not improved	321
Ganze	Bamba Girls Secondary	Day & Boarding	Not improved	173
Ganze	Mayowe Secondary	Day	Not improved	404
Ganze	Sosoni Secondary	Day	Not improved	233
Ganze	Vyamabni Secondary	Day	Not improved	630
Kaloleni	Brighter Star Secondary	Day	Not improved	1240
Kaloleni	Chanagande Secondary	Day & Boarding	Not improved	944
Kaloleni	Kinarani Secondary	Day Only	Not improved	162
Kaloleni	Kizurini Secondary	Day Only	Not improved	1004
Kaloleni	Maandani Secondary	Day Only	Not improved	231
Kaloleni	Mariakani Secondary	Day & Boarding	Not improved	1076
Kaloleni	Miyani Secondary	Day	Not improved	492
Kaloleni	Moi Kadzonzo Girls Secondary	Boarding Only	Not improved	1022
Kaloleni	Mutsengo Secondary	Day	Not improved	406
Kaloleni	Ngala Memorial Secondary	Day & Boarding	Not improved	983
Kaloleni	St Georges High	Boarding Only	Not improved	1028
Kaloleni	St John's Girls Secondary	Boarding Only	Not improved	1568
Kaloleni	Tsangatsini Secondary	day	Not improved	782
Kaloleni	Kaloleni Girls Secondary	boarding	Not improved	363
Kaloleni	Tsagwa Secondary	Day	Not improved	218
Kaloleni	St. Michael Secondary	boarding	Not improved	216
Kaloleni	Mwijo Secondary	Day	Not improved	213
Kaloleni	Makomboani Secondary	Day	Not improved	315
Kaloleni	Mwareni Secondary	Day	Not improved	1011
Kaloleni	Kirumbi Secondary	boarding	Not improved	455
Kaloleni	Mnazi Mmwenga Secondary	Day	Not improved	175
Kaloleni	Shangiya Secondary Shool	Day	Not improved	189
Kaloleni	Migundi Secondary	Day	Not improved	492
Kilifi North	Arabuko Forest High	boarding	Improved jiko	12948
Kilifi North	Bahari Girls Secondary	Boarding Only	Improved jiko	1413
Kilifi North	Baraka Chembe Secondary	Day	Improved jiko	
Kilifi North	Canon Mweri Memorial Secondary	Day Only	Improved jiko	



Sub-county	Name	Day & Boarding	Primary stove	Average student population
Kilifi North	Chumani Secondary	Day & Boarding	Not improved jiko	678
Kilifi North	Eureka Girls Secondary	Day	Improved jiko	
Kilifi North	F.b. Tuva Memorial Secondary Mijomboni	Day Only	Improved jiko	
Kilifi North	Fumbini Secondary	Day	Not improved jiko	671
Kilifi North	Gede Secondary	Boarding	Improved jiko	697
Kilifi North	Jimba-Gede Secondary	Day	Improved jiko	
Kilifi North	Kakuyuni Secondary	Day	Improved jiko	425
Kilifi North	Katana Ngala Secondary	Day Only	Not improved jiko	1308
Kilifi North	Kilifi Township Secondary	Boarding Only	Not improved jiko	1122
Kilifi North	Bofa Secondary	Day	Not improved jiko	229
Kilifi North	Majaoni Secondary	Day Only	Not improved jiko	1191
Kilifi North	Mdzongoloni Secondary	Day	Not improved jiko	377
Kilifi North	Mnarani Secondary	Day	Improved jiko	625
Kilifi North	Mzizima Secondary	Day	Improved jiko	
Kilifi North	Ngala Memorial Girls Secondary	Day & Boarding	Improved jiko	1442
Kilifi North	Ngerenya Secondary	Day	Not improved jiko	553
Kilifi North	Marafiki Secondary	Day	Not improved jiko	173
Kilifi North	Roka Secondary	Day Only	Not improved jiko	438
Kilifi North	Sda Secondary	Day	Improved jiko	
Kilifi North	Soko Secondary	Day & Boarding	Not improved jiko	456
Kilifi North	Takaungu Secondary	Day Only	Improved jiko	
Kilifi North	Uyombo Girls Secondary	Boarding	Not improved jiko	250
Kilifi North	St Thomas Secondary	Boarding	Not improved jiko	1318
Kilifi North	Kiwandani Secondary	Day Only	Not improved jiko	557
Kilifi North	Mkongani Secondary	Day Only	Not improved jiko	396
Kilifi North	Koroshio Secondary	Day Only	Not improved jiko	151
Kilifi North	Pwani School For The Deaf Secondary	Boarding Only	Not improved jiko	103
Kilifi South	Chasimba High	Day	Not improved jiko	186
Kilifi South	Dzitsoni Secondary	Day & Boarding	Not improved jiko	484
Kilifi South	K.p Senior Secondary	Day Only	Improved jiko	980
Kilifi South	Katikirieni Secondary	Day	Not improved jiko	370
Kilifi South	Lutsangani Secondary	Day & Boarding	Not improved jiko	850
Kilifi South	Mayowe Secondary	Day	Not improved jiko	404
Kilifi South	Msumarini Secondary	Day Only	Improved jiko	832
Kilifi South	Mwarakaya Secondary	boarding	Not improved jiko	317
Kilifi South	Ngombeni Girls Secondary	Day	Not improved jiko	750
Kilifi South	Pingilikani Secondary	Day	Improved jiko	
Kilifi South	Shariani Secondary	Day Only	Not improved jiko	



Sub-county	Name	Day & Boarding	Primary stove	Average student population
Kilifi South	St. Teresas Secondary	Day & Boarding	Not improved jiko	621
Kilifi South	Ziani Secondary	Day	Improved jiko	
Kilifi South	Vipingo Secondary	Day	Not improved jiko	456
Kilifi South	Mtomondoni Secondary	Day	Improved jiko	456
Kilifi South	Mtepeni Secondary Sc	Day	Improved jiko	531
Kilifi South	Junju Secondary Sc	Day	Not improved jiko	320
Kilifi South	Gongoni Secondary	Day	Not improved jiko	207
Kilifi South	Kadzinuni Secondarysc	Day	Not improved jiko	287
Kilifi South	Dindiri Secondary Sc	Day	Improved jiko	
Kilifi South	Bundacho Secondary	Day	Not improved jiko	200
Kilifi South	Mbuyuni Secondary	Day	Not improved jiko	250
Kilifi South	Pual Haris Secondary	Day	Not improved jiko	482
Magarini	Adu Secondary	Day Only	Improved jiko	
Magarini	Fundisa Secondary	Day	Improved jiko	
Magarini	Galana Secondary	Day & Boarding	Improved jiko	706
Magarini	Garashi Ack Rosemary Memorial Secondary	Day Only	Improved jiko	
Magarini	Garashi Secondary	Day	Improved jiko	
Magarini	Magarini Secondary	Day & Boarding	Improved jiko	556
Magarini	Mambrui Secondary	Day Only	Improved jiko	360
Magarini	Mapimo Girls Secondary	Day Only	Improved jiko	450
Magarini	Marafa Secondary	Boarding Only	Improved jiko	412
Magarini	Marereni Secondary	Day	Improved jiko	
Magarini	Ramada Secondary	Day	Improved jiko	
Magarini	Waresa Secondary	Day	Improved jiko	
Malindi	Barani Secondary	Day Only	Improved jiko	
Malindi	Ganda Secondary	Day	Improved jiko	
Malindi	Jirole High	Day Only	Improved jiko	470
Malindi	Kakoneni Girls Secondary	Boarding Only	Improved jiko	628
Malindi	Kakuyuni Boys High	Boarding Only	Improved jiko	
Malindi	Kijiwetanga Secondary	Day	Improved jiko	
Malindi	L.b Maitha Secondary	Day Only	Improved jiko	
Malindi	Langobaya Secondary	Day	Improved jiko	
Malindi	Malindi High	Day Only	Improved jiko	1220
Malindi	Mandunguni Secondary	Day	Improved jiko	
Malindi	Maziwani Secondary	Day	Improved jiko	
Malindi	Mkao Moto Secondary	boarding	Improved jiko	
Malindi	Sabaki Secondary	Day	Improved jiko	
Malindi	Soso Bora Secondary	Day	Improved jiko	

Sub-county	Name	Day & Boarding	Primary stove	Average student population
Malindi	Mekatilili Secondary	boarding	Improved jiko	
Malindi	Mkondoni Secondary	Day	Improved jiko	
Malindi	Kibokoni Secondary	Day	Improved jiko	
Malindi	Majivuni Secondary	Day	Improved jiko	
Malindi	Ack Bishop Kalu Secondary		Improved jiko	
Malindi	Muyeye Secondary		Improved jiko	
Malindi	Chakama Secondary		Improved jiko	
Malindi	Jimba Gede Secondary		Improved jiko	
Malindi	Baldachino Secondary		Improved jiko	
Malindi	Shomani Secondary		Improved jiko	414
Malindi	Mida Secondary		Improved jiko	
Malindi	Mbaraka Chembe Secondary		Improved jiko	
Malindi	Meny Hart Secondary		Improved jiko	
Malindi	Watamu Secondary		Improved jiko	
Malindi	F B Tuva Secondary		Improved jiko	
Rabai	Bofu Secondary		Not improved jiko	531
Rabai	Bwagamoyo Secondary		Not improved jiko	149
Rabai	Dr Krapf Memorial Secondary	Day & Boarding	Not improved jiko	679
Rabai	Jimba Secondary		Not improved jiko	306
Rabai	Kambe Secondary	Day Only	Not improved jiko	343
Rabai	Kasidi Secondary	Day Only	Not improved jiko	784
Rabai	Kombeni Girls Secondary	Boarding Only	Not improved jiko	1093
Rabai	Mbarani Secondary		Not improved jiko	196
Rabai	Mikahani Secondary		Not improved jiko	260
Rabai	Rabai Secondary	Day Only	Not improved jiko	1032
Rabai	Rev Canon Kuri Secondary		Not improved jiko	504
Rabai	Ribe Boys Secondary	Boarding Only	Not improved jiko	1172
Rabai	Ribe Girls Secondary	Boarding Only	Not improved jiko	1221
Rabai	Mwandodo Secondary		Not improved jiko	370
Rabai	Mikomani Secondary		Not improved jiko	278
Rabai	Kawala Secondary		Not improved jiko	125
Rabai	Cannonkari Secondary		Improved jiko	
Rabai	Kamoti Secondary		Improved jiko	
Rabai	Kajiwe Secondary		Not improved jiko	577
Rabai	Changombe Secondary		Not improved jiko	805
Rabai	Chiferi Secondary		Not improved jiko	288



