Covenant of Mayors
in Sub-Saharan Africa

NAKURU COUNTY
COUNTY OF UNLIMITED OPPORTUNITIES

ACCESS TO ENERGY ASSESSMENT

Nakuru County, Kenya

CoM SSA is co-funded by:

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DEUTSCHE ZUSAMMENARBEIT

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Abbreviations

AEA	Access to Energy Assessment
BEI	Baseline Emissions Inventory
CIDP	County Integrated Development Plan
CoM SSA	Covenant of Mayors Sub-Saharan Africa
EC	European Commission
EPRA	Energy and Petroleum Regulatory Authority
ESI	Electricity Supply Industry
ESMAP	Energy Sector Management Assistance Program
EU	European Union
FiT	Feed-in-Tariff
GCoM	Global Covenant of Mayors
GDC	Geothermal Development Company
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIS	Geographic Information System
GoK	Government of Kenya
IPPs	Independent Power Producers
KenGen	Kenya Electricity Generating Company
KETRACO	Kenya Electricity Transmission Company
KIHBS	Kenya Integrated Household Budget Survey
KNBS	Kenya National Bureau of Statistics
KPLC	Kenya Power and Lighting Company
KES	Kenyan Shillings
LCPDP	Least Cost Power Development Plan
MoE	Ministry of Energy
MTF	Multi-Tier Framework
MW	Megawatts

NAP	National Adaptation Plan
NDC	Nationally Determined Contribution
NLC	National Land Commission
NSSF	National Social Security Fund
PPP	Public Private Partnership
PV	Photovoltaic
RE	Renewable energy
RERAC	Renewable Energy Resource Advisory Committee
REREC	Rural Electrification and Renewable Energy Corporation
RVA	Risk and Vulnerability Assessment
SCODE	Sustainable Community Development Services
SDGs	Sustainable Development Goals
SE4All	Sustainable Energy 4 All
SEACAP	Sustainable Energy Access and Climate Action Plan
SPV	Special Purpose Vehicles

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1. The Covenant of Mayors Sub-Saharan Africa (CoM SSA) and Sustainable Energy Access and Climate Action Plans (SEACAPs)

1.1 The Covenant of Mayors Sub-Saharan Africa (CoM SSA)

The Covenant of Mayors Sub-Saharan Africa (CoM SSA) is an initiative launched by the European Union (EU) to support local authorities in sub-Saharan Africa in the climate challenge and in their efforts to ensure access to clean energy. It is the "regional covenant" or chapter of the Global Covenant of Mayors for Climate & Energy (GCoM). CoM SSA is delivered through a partnership of global and local city networks as well as initiatives funded by the European Commission (EC). It is a bottom-up and voluntary initiative that invites cities to commit, define and meet ambitious and realistic energy access and climate goals and targets set by themselves, in line with GCoM requirements. This means that targets are at least as ambitious as cities' respective government's Nationally Determined Contribution (NDC) under the Paris Agreement. Furthermore, targets need to be in line with National Adaptation Plans (where these exist) and be consistent with the principles around energy access and urban sustainability embodied in the Sustainable Development Goals (SDGs). Local authorities are encouraged to voluntarily commit to the implementation of a climate and energy action plan in their area of influence. They are also encouraged to define long-term vision actions towards a sustainable future based on the pillars of climate change mitigation and adaptation, and sustainable, affordable and secure access to energy. CoM SSA is open to any city in sub-Saharan Africa, regardless of the size. In order to translate the political commitment into practical measures, CoM SSA signatories commit to produce and implement a strategic and operational document called the Sustainable Energy Access and Climate Action Plan (SEACAP).

1.2 Sustainable Energy Access and Climate Action Plans (SEACAPs)

The Sustainable Energy Access and Climate Action Plan (SEACAP) is the key document that sets the strategies, plans and actions for a sustainable and low greenhouse gas (GHG) emission development pathway, while including climate change adaptation actions and ensuring access to secure, affordable and sustainable energy, in response to the current and future impacts of climate change in the region. The SEACAP is both a strategic and an operational document. It uses the results of the Baseline Emissions Inventory (BEI) to identify the best fields of action and opportunities for reaching the local authority's greenhouse gas (GHG) emission reduction targets. It is based on the climate change Risk and Vulnerability Assessment (RVA), which identifies the most relevant city climate hazards and vulnerabilities. It also includes an Access to Energy Assessment (AEA), which forms the basis for the development of a plan to improve the access to secure, sustainable, affordable and reliable energy. The SEACAP defines concrete measures for climate mitigation, adaptation and access to sustainable energy, with timeframes and assigned responsibilities, translating the long-term strategy into action. Signatories commit to submitting their energy and climate action plans by Year 3 at the latest (following adhesion to the initiative).

1.3 Phases of the SEACAP development within the Access to Energy pillar

The Access to Energy pillar of the Sustainable Energy Access and Climate Action plan (SEACAP) development involves four phases:

i. **Initiation phase** – Activities in this phase include the identification of national action plans on energy access, mobilising and engaging stakeholders and affirming political commitment of the heads of the municipality and the national government to the SEACAP development.

ii. **Planning phase** – This phase includes pre-assessment and development stages. Thus, it involves undertaking a baseline assessment of the status of energy access in the local government via primary and secondary data collection. The baseline assessment offers an opportunity for local government authorities to obtain data specific to the local government, thus increasing awareness on the existing status and providing a premise for further action to improve the status quo. The data collected after involving stakeholders and data suppliers is then analysed and an energy access baseline report developed. Thereafter, there is the visioning, target setting and development of an action plan to achieve the set targets. These actions which aim at promoting energy access range from the development of enabling policies, expansion of the national grid, introduction of mini-grids and solar home systems into unserved communities, encouraging market-based approaches to the distribution of clean cookstoves, raising awareness of consumers on efficiency in cooking and electricity use, and so on.

iii. **Implementation phase** – This phase involves delivering practical actions, based on the actions that have been prioritised during the action planning process.

iv. **Monitoring and Reporting phase** – This phase involves reviewing progress and readjusting priorities. The proposed actions are monitored to ensure that the set targets are achieved. Specific procedures and processes for each of the actions are confirmed, while maintaining constant communication with the stakeholders throughout. On a regular basis, the progress made is assessed and priorities are adjusted to fit the current situation as needed. A progress report is to be submitted every second year after the year SEACAP was developed, for monitoring and evaluation.

This document is the **Access to Energy Assessment**, the baseline assessment for the Energy Access pillar. This document and the County Energy Plan will form the basis for target setting and action planning in the development of the Access to Energy pillar of the SEACAP in Nakuru County, Kenya.

1.4 Purpose of the Access to Energy Assessment

The Access to Energy Assessment (AEA) is developed as a dashboard of multiple indicators that help define a clear picture of the current energy access status within the local authority. In the framework of the CoM SSA initiative, access to energy is assessed under two broad categories: access to electricity in households and public buildings, and access to clean cooking.

1.4.1 Assessing access to electricity

To assess access to electricity, ten key indicators for electricity access are recommended for assessment under the CoM SSA initiative. There is an overall indicator and nine other indicators as shown in Annex 1 of this document. The overall indicator gives a general picture of the current situation of the access to electricity in the local authority. This includes aggregated data that help building a starting point to be further developed with the use of other specific indicators related to the attributes - security, affordability and sustainability. The access to electricity indicators, attributes and the respective codes are elaborated upon further in Annex 1.

1.4.2 Assessing access to clean cooking

To assess access to clean cooking, nine key indicators are recommended for assessment under the CoM SSA Initiative. As with the assessment for access to electricity, there is an overall indicator, then eight other indicators as indicated in Annex 1. The overall indicator gives a general picture of the current situation of the access to clean cooking in the local authority. This indicator includes aggregated data that helps in building a starting point to be further developed with the use of the other specific attributes of sustainability, security and affordability. The clean cooking indicators are further elaborated in Annex 1.

The chapters that follow provide a general overview of Nakuru County, energy access policies, strategies, stakeholders at the national and county level, and most importantly, the methodology used to assess energy access in Nakuru County and the resulting findings.

2. Nakuru Country overview

Nakuru County is among the 47 counties of the Republic of Kenya that came into existence with the enactment of Kenyan Constitution in 2010. The county is cosmopolitan, comprising a populace of different ethnicities and nationalities (KNBS, 2019). According to the 2019 National Population and Housing Census, the county's population was approximately 2.16 million in 2019, made up of 1,077 million males, 1,084 million females, and 95 intersexes. Approximately 33% of people in the county are aged 18–35, indicating a predominantly youthful population (KNBS, 2019). Furthermore, 54.2% live in rural areas, and 45.8% live in urban areas.

The county covers an area of approximately 7,498.8 km² with its capital being Nakuru Town. The county is divided into eleven administrative subcounties namely: Nakuru East, Nakuru West, Naivasha, Molo, Njoro, Kuresoi North, Kuresoi South, Rongai, Bahati, Subukia and Gilgil as shown in **Figure 1**. These 11 sub-counties are further divided into 31 Divisions, 121 Locations, and 265 sub-locations.

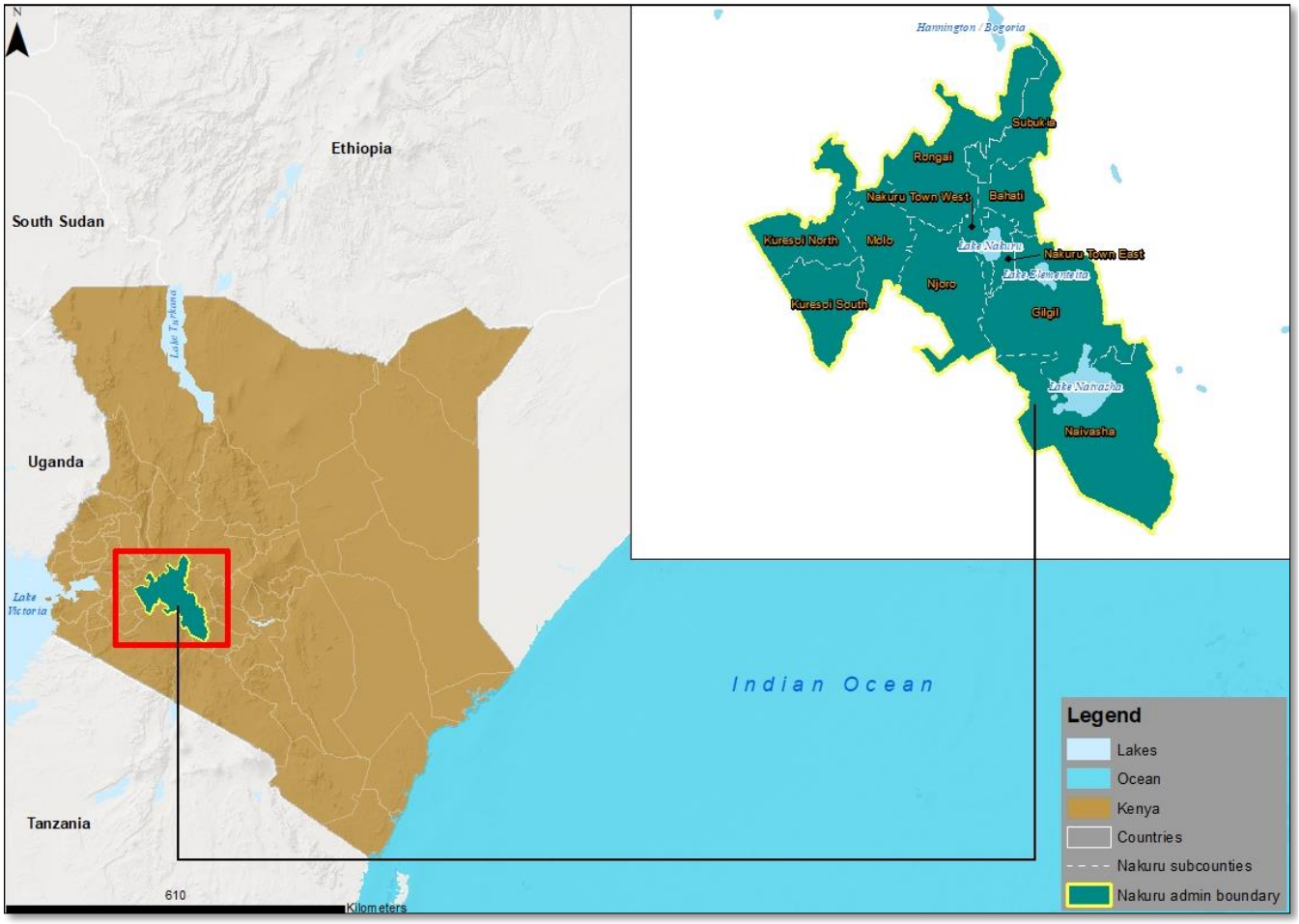


Figure 1: A map of Nakuru County and its subcounties (based on KNBS 2019 census data)

Table 1 depicts the population of the different subcounties, land surface area, population density and household size, in comparison to county and national level. This shows that the most populated subcounty is Naivasha, and the subcounty with the highest population density is Nakuru West with 2,764 persons per km².

Table 1: Summary of Nakuru County and subcounty demographics compared to Kenyan demographics

Sub-county	Total population	Male population	Female population	Total number of households	Number of Conventional households	Number of Group Quarters	Land area,Sq. Km	Density, Persons Per Sq. Km	Household size
KENYA	**47564296**	**23548056**	**24014716**	**12143913**	**12043016**	**100897**	**580895**	**82**	**3.9**
NAKURU	**2162202**	**1077272**	**1084835**	**616046**	**598237**	**17809**	**7505**	**288**	**3.5**
NAIVASHA	355383	179222	176132	117633	111493	6140	1958	181	3.0
NJORO	238773	118361	120408	61271	61156	115	699	341	3.9
NAKURU NORTH	218050	106155	111880	61728	61582	146	387	563	3.5
RONGAI	199906	99976	99922	52348	52248	100	988	202	3.8
NAKURU WEST	198661	101797	96854	64481	64429	52	72	2764	3.1
NAKURU EAST	193926	92956	100960	61398	60066	1332	231	840	3.2
GILGIL	185209	92955	92247	58920	49405	9515	1075	172	3.1
KURESOI NORTH	175074	87472	87599	40359	40168	191	618	283	4.3
MOLO	156732	78129	78598	41462	41439	23	483	324	3.8
KURESOI SOUTH	155324	78204	77117	34627	34543	84	591	263	4.5
SUBUKIA	85164	42045	43118	21819	21708	111	402	212	3.9

(Source: KNBS, 2019b)

A snapshot of key demographic, economic and geographic indicators in Nakuru County have been outlined in **Table 2**.

Table 2: Nakuru County overview

Sector	Description
1. Geography	
Location:	The county is located between longitudes 35.41 º East or 35 º 24' 36" East and 36.6 º East or 36 º36' 0" East and latitude 0.23 º North or 0 º13' 48" North and 1.16 º South or 1º 9'36" South. Nakuru is among the 14 counties within the Rift Valley region.
Environmental and climate change challenges	Environmental degradation in Nakuru County is mainly as a result of inappropriate farming methods, poor solid and liquid waste disposal, soil erosion, inadequate sanitary facilities, massive felling of trees for firewood, encroachment of forest reserves, timber and clearing land for agriculture.
Land area (2019)	Nakuru County covers a land area of 7,505 km^2, compared to a national land area of 580,895.4 km^2 (making up about 1.3% of total land area in Kenya).
2. Demography	
Population (2019)	2,162,202 people, with 49.8% (1,077 million) males, 50.2% (1,084 million) females, less than 0.1% (95) intersexes. The national population of Kenya is 47,564,296 (KNBS, 2020).
Household size (2019)	3.5 persons per household in Nakuru county, compared to a national average of 3.9 (KNBS, 2020) The most populated households are found in Kuresoi South, with an average household size of 4.5 persons.
Population density (2019)	288 persons/km2 in Nakuru County, compared to 82 people/km^2 in Kenya. Nakuru West has a very high population density of 2,764 persons/km^2 due to its very small land area of 72 km^2.
Number of households (2019)	616,723 households in Nakuru County, with an average household size of 3.5 persons (KNBS, 2019a), compared to 12,143,913 households in Kenya, with an average household size of 3.9 persons. The subcounty with the highest number of households is Naivasha (117,633) and the lowest is Subukia (21,819).

Sector	Description
3. Governance and leadership	
County capital:	The county's capital is Nakuru Town.
Number of subcounties and wards	There are 11 subcounties, 31 divisions, 121 locations, 265 sublocations. Subcounties include: Nakuru East, Nakuru West, Naivasha, Molo, Njoro, Kuresoi North, Kuresoi South, Rongai, Bahati, Subukia and Gilgil.
Urban areas	There is an urban population of 1,047,080 (48.4% of county population) comprising of 49.4% males and 50.6% females. There are 339,787 households covering a total land surface area of 949 km^2 and a population density of 1,103 persons per km^2. The major urban centres are: Nakuru, Naivasha, Mai Mahiu, Molo, Njoro, Gilgil, Subukia, Olenguruone, Bahati, Rongai, Salgaa, Dundori and Mau Narok (County Government of Nakuru, 2018).
Rural areas	The rural population of 1,115,122 people (51.6% of county population) comprises of 50.2% males and 49.8% females. There are 276,259 households (44.8% of households in the county) covering a total surface area of 6,556 km^2 (87.3% of total land area in county) and the population density is 170 persons per km^2.
Informal settlements	The major informal settlements are in Nakuru East (Bondeni, Manyani, and Lakeview), Nakuru West (Ronda, Kaptembwo, and Gituima), Gilgil (Kampi Somali, Maina, and Makaburi), Naivasha (Lakeview, Kihoto), Molo (Casino, Kasarani), and Njoro (Industrial area, Juakali, Jewathu, Bondeni).
4. Economy	
GDP	The county's Gross Domestic Product (GDP) for 2019 was estimated at KES 613 billion (at current prices), accounting for 6.9% of Kenya's GDP.
Unemployment levels	According to the Kenya Integrated Household Budget Survey (KIHBS) report 2015–16, approximately 22.9% of the labour force remains unemployed. Of these, 46% of the unemployed are female and 54% are male.
Main economic activities/industries:	The major economic activities within Nakuru County are: agribusiness, financial services, and tourism. Nakuru County's economy is built around agriculture, which accounts for approximately 60% of total economic activity (County Government of Nakuru, 2018).
Tourist attractions:	The National Parks are the major tourist attractions in the county. These are: Lake Nakuru National Park, Hells Gate National Park and Mt. Longonot National Park. Other tourist sites include: Menengai Crater, Subukia Shrine, Lord Egerton Castle, Lake Naivasha, Lake Elementaita, Hyrax Hill prehistoric site, Ol-doinyo Eburru volcano and Mau forest (County Government of Nakuru, 2018).

2.1 Energy policy and regulatory framework

2.1.1 National level

Most of the policies influencing the energy sector in Kenya are provided in or backed by the Energy Act, 2019. This section of the report focuses on the most relevant policies enabling the improvement of energy access in Nakuru County. As such, **Table 3** provides an overview of relevant policies, strategies and plans at the national level.

Table 3: National policies, legislations and strategies relevant to the energy sector

Policy/strategy	Relevance
Least Cost Power Development Plan (LCPDP 2020–2040)	The LCPDP is a Kenyan Energy Sector Report, intended to guide the power sector on the status, generation and transmission expansion opportunities, as well as resource requirements for expansion programmes. Timelines for renewable energy (RE) project implementation in Kenya are driven by the LCPDP, not counties. For instance, all plans for energy generation in Nakuru County must be included in the LCPDP and there must be harmony between county energy plans and the LCPDP.
The Energy (Mini-Grid) Regulations, 2018	Given that improving energy in Nakuru County will entail the development of mini-grids in areas far from the national grid, the regulations pertaining to this sector are quite relevant. EPRA (Electricity and Petroleum Regulatory Authority) was expected to publish the Mini-Grid Regulations and the Regulatory Impact Assessment for public comment in the second half of 2019.
Sustainable Energy for All (SE4All) Action Agenda	Kenya opted in to the SE4All Initiative and has developed an action agenda, which is a sector-wide, long-term vision for 2015–2030. The agenda outlines how the country will achieve its SE4All goals of universal access to modern energy services, increase the rate of energy efficiency, and increase to 80% the share of RE in the energy mix by 2030.
REREC Strategic Plan 2017–2021	This strategic plan focuses on the rolling out of RE and mini-grids in achieving its electrification targets for public facilities. The plan provides a roadmap for electrification of public facilities and nearby households. The plan had projected to electrify 28,323 public facilities by 2020, of which 3,787 will be off-grid areas electrified through solar PV.
National Electrification Strategy, 2018	Off-grid solutions are a major component of the National Electrification Strategy launched in 2018. It is expected to provide 2 million of the 5.7 million new connections required for universal electricity access by 2022 in Kenya. Hence, the least cost and most effective electrification solutions in this electrification strategy are an important consideration for Nakuru County.
Kenya Electricity Sector Investment Prospectus, 2018–2022	The current Kenya Electricity Sector Investment Prospectus was developed by energy sector institutions. It presents investment and financing opportunities in geothermal development, power generation, electricity transmission and distribution, off-grid electrification, and energy efficiency. This investment prospectus outlines areas for the mobilisation of resources and multi-stakeholder engagement to facilitate implementation of priority projects in the electricity sector. It also presents the opportunity for increased private-sector participation across all subsectors through the private-public partnerships framework, feed-in tariffs, and renewable energy auctions framework, among other things.
Feed in Tariff (FiT) Policy (2008) – amended 2010, 2012	The FiT Policy offers a framework for electricity generated from RE sources (specifically wind, biomass and small hydro) in order to safeguard the investments made by the respective developers in undertaking feasibility studies; and to boost the development of RE sources for electricity generation. FiTs allow power producers to sell RE generated electricity to the off-taker (KPLC) at a predetermined tariff for a given period of time (Ministry of Energy, 2012). The FiTs per RE technology are detailed in the FiT policy.

Policy/strategy	Relevance
The VAT Act, 2018, and the Finance Act, 2020	The VAT Act, 2018, exempted all specialised solar equipment and accessories from paying VAT. However, the Act restricts specialised equipment to only those used in the development and generation of wind and solar energy, including deep-cycle batteries which use or store solar power. The introduction of 8% VAT on petroleum products (including kerosene) in this policy, amongst other measures, significantly increases the price of kerosene and may render kerosene unaffordable for the off-grid community. This may increase the demand for solar lighting devices. However, on the 30th of June 2020, the President of Kenya enacted the Finance Act, effective from July 2020, which will result in the introduction of 14% VAT on off-grid solar products that were exempted in the previous Finance Act (Republic of Kenya, 2020).
Kenya's Nationally Determined Contribution	Kenya's Nationally Determined Contribution (NDC) is one of the drivers of RE developments in the country. In 2015, Kenya committed to reducing its GHG emissions by 30% by 2030 relative to the BAU scenario of 143 $MtCO_2e$; and in line with its sustainable development agenda. This is also subject to international support in the form of finance, investment, technology development and transfer, and capacity building (Ministry of Environment and Natural Resources, 2015). In Kenya's updated NDC of 2020, Kenya commits to abating GHG emissions by 32% by 2030 relative to the BAU scenario of 143 $MtCO_2e$ (Ministry of Environment and Forestry, 2020).
The Public Private Partnerships (PPP) Act, 2013	The Kenyan Parliament enacted the Public Private Partnerships Act, 2013, to provide for the participation of the private sector in the financing, construction, development, operation and maintenance of infrastructure projects of the government through concessions or other contractual arrangements. The Act also established the Public Private Partnership Unit to regulate, monitor and supervise the implementation of project agreements on infrastructure (Njoroge Regeru & Co., n.d.).
Energy (Solar Photovoltaic Systems) Regulations, 2012	These Regulations, made under Section 110 of the Energy Act, 2006, provide rules and standards for the installation of solar photovoltaic (PV) systems in Kenya. They apply to a solar PV system manufacturer, importer, vendor, technician, contractor, system owner, and to solar PV system installation and consumer devices.
Energy (Electricity Licensing) Regulations, 2012	These Regulations apply to any person who engages or intends to engage in the generation, transmission, distribution and supply of electrical energy in Kenya as per the requirements of the Energy Act (Republic of Kenya, 2012b). Under the Licensing Regulations, no permit or licence is required to generate electricity where the electricity generated does not exceed 1 MW and is generated for own consumption. A permit is however required for the generation and supply of electrical energy not exceeding 3 MW and a licence is required for generation, transmission, distribution or supply of electrical energy exceeding 3 MW (Anjarwalla & Khanna, n.d.).
Kenya Electricity Grid Code	The Kenya Electricity Grid Code (Energy Regulatory Commission, 2008) is the primary technical document of the electricity supply industry (ESI), collating the majority of the technical regulations covering the generation, transmission, distribution and supply of electrical energy (S2BIOM, 2008).

(Source: ICLEI Africa, 2021)

2.1.2 Nakuru County level

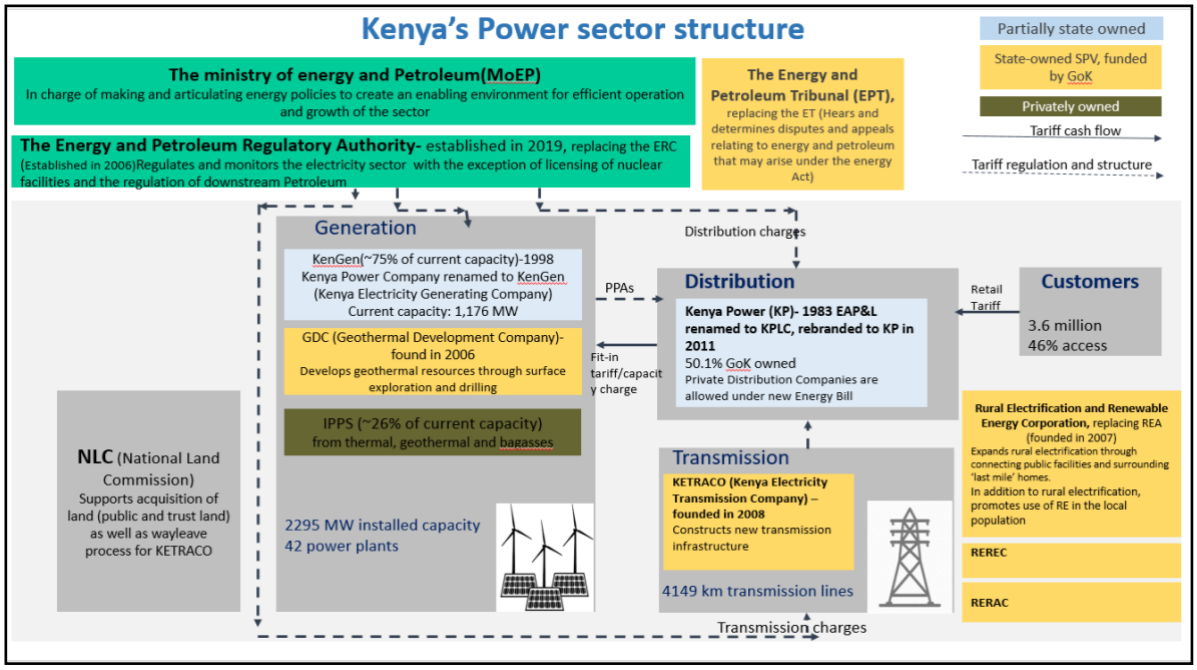
Outlined in **Table 4** are policies, strategies and plans at the county level that are relevant to improving energy access:

Table 4: Existing policies, strategies and plans supporting sustainable energy access

Policy/plan	Description
Nakuru County Integrated Development Plan (2018 – 2022)	As inferred from the name, this is a county development plan which is updated every 5 years. The current CIDP in Nakuru County is valid from 2018 to 2022, and cuts across all the county departments and sectors. The CIDP is premised on existing enabling regulations like the County Government Act, 2012, the Urban Areas and Cities Act, 2011 and the Public Finance Management Act, 2012 amongst others. Priorities within the CIDP include industrialisation of the agricultural sector, improving access to roads and communication network, sustainable environmental management, safety, childhood education, equality, amongst others (County Government of Nakuru, 2018).
Draft Nakuru County Clean Energy Policy (2016)	This draft policy provides an overarching framework for the County's plans, programmes and initiatives relating to sustainable clean energy supply and use by 2022: maintaining energy security, maximising economic opportunities, cutting emissions, and protecting the most vulnerable. The policy will ensure that Nakuru accelerates climate change mitigation measures through clean energy development and energy efficiency and conservation measures (County Government of Nakuru, 2016).
Nakuru County Clean Energy Action Plan	This clean energy action plan is prepared in response to operationalise the Nakuru County Clean Energy Policy. This document provides an overarching framework for the county's plans, programmes and initiatives relating to sustainable clean energy supply and use by 2022: maintaining energy security, maximising economic opportunities, cutting emissions, and protecting the most vulnerable. The plan will ensure that the county accelerates climate change mitigation measures through clean energy development and energy efficiency and conservation measures.
Nakuru County Energy Plan (underway)	As per the Energy Act, 2019, all counties in Kenya are mandated to develop a County Energy Plan. As per the guidelines provided by the Ministry of Energy for the development of this County Energy Plan, it is very comprehensive, addressing all sectors consuming and producing energy within the county, including energy efficient measures. For Nakuru County, GIZ, through the CoM SSA project, has contracted a service provider to develop Nakuru County's Energy Plan, which should be completed by the end of 2022.

2.2 Key stakeholders in the energy sector

Energy generation, transmission, distribution and regulation at the national level in Kenya is managed by a number of institutions, most of which are public, and some of which are parastatals. These are summarised in **Figure 2**.



(Source: ICLEI Africa, 2021)

Figure 2: The organisational structure of Kenya's energy sector

Table 5: Actors in Kenya's power sector relevant to Nakuru County

Entity	Role
Generation	
Kenya Electricity Generating Company (KenGen)	The company accounts for about 75% of the installed capacity from various power generation sources that include hydropower, thermal, geothermal and wind (Republic of Kenya, 2018) with 85% of its generation being clean. Some of its generating plants are located in Nakuru County, Olkaria I (Units 1, 2 and 3 (retired recently but still operable), Olkaria II, Olkaria IV, Olkaria I (Unit 4&5), Olkaria V geothermal power plants which make up a total of 639.4 MW of installed capacity (KenGen, n.d.).
Geothermal Development Company	This is a fully owned government Special Purpose Vehicle (SPV) intended to undertake surface exploration of geothermal fields, undertake exploratory, appraisal and production, drilling, developing and managing proven steam fields and enter into steam sales agreements with investors.
Independent Power Producers (IPPs)	These are private investors in the power sector involved in generation under the FiT Policy. Collectively, they account for about 26% of the country's installed capacity from thermal, geothermal and bagasse.
Distribution	
The Kenya Power and Lighting Company (KPLC)	It is governed by the State Corporations Act and is responsible for electricity transmission and all distribution systems in Kenya. The transmission system comprises 220kV, 132kV and 66kV transmission lines. The ownership structure consists of 50.1% ownership by the National Social Security Fund (NSSF) and the GoK, and 49.9% owned by private shareholders.
Private distribution companies	This is currently the sole mandate of KPLC (as of when this report was written) (Republic of Kenya, 2018).

Entity	Role
Transmission	
Kenya Electricity Transmission Company (KETRACO)	This company is 100% owned by the government of Kenya; its mandate is to plan, design, construct, own, operate and maintain new high voltage (132 kV and above) electricity transmission infrastructure that will form the backbone of the national transmission grid and regional inter-connections.
KPLC	The KPLC is also involved in the transmission sector to a lesser extent.
Others	
The Energy and Petroleum Regulatory Authority (EPRA)	EPRA has regulatory control over the energy sector in the country, including RE. Hence, any licence, supervision of compliance with conditions of the licences, sanctions and penalties for non-compliance to requirements of energy policies in Nakuru County are issued and enforced by EPRA.
Rural Electrification and Renewable Energy Corporation (REREC)	REREC is of central importance due to its primary role of expanding rural electrification and the promotion of RE in the local population. REREC plays a central role in legislation, research and development, and international collaborations in promoting the use of RE.
Renewable Energy Resource Advisory Committee (RERAC)	RERAC is an inter-ministerial committee that advises the Cabinet Secretary for Energy and Petroleum on criteria for the allocation of renewable resources, licensing of RE resource areas, management of water towers and catchment areas, development of multi-purpose projects such as dams and reservoirs for power generation, and management and development of RE sources.

(Source: ICLEI Africa, 2021)

2.3 National and county mandates around energy generation operation and regulation

The Energy Act, 2019 provides a detailed breakdown of the roles and responsibilities of national and county governments on aspects around energy planning, regulation, operation and development as summarised in **Table 6**.

Table 6: Roles of national and county governments in Kenya's energy structure

Role of national government	Role of county government
Energy planning	
1. Policy formulation and National Energy Plans a) Formulation of the National Energy Policy b) Preparing Integrated National Energy Plan, incorporating coal, RE & electricity master plans c) Provision of land and rights of way for energy infrastructure	**1. County energy planning** a) Preparation of county energy plans, incorporating coal, RE and electricity master plans b) 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 production of bio-energy feed-stocks c) Provision of land and rights of way for energy infrastructure d) Facilitate energy demand by planning for industrial parks and other energy consuming activities e) Preparation and implementation of disaster management plans

Role of national government	Role of county government
Energy regulation	
2. National energy regulation a) Regulation and licensing of importation, transportation, storage of coal for the purposes of electricity generation b) Regulation and licensing of production, conversion, distribution, supply, marketing and use of RE c) Regulation and licensing of generation, importation, exportation, transmission, distribution, retail and use of electrical energy d) Approval of energy purchase agreements as well as network service and common user facility contracts. e) Protection of consumer, investor and other stakeholder interests. f) Preparation and enforcement of regulations and standards. g) Formulation of national codes for energy efficiency and conservation in buildings h) Issuance of energy saving certificates to enhance energy efficiency and conservation i) Setting, review and adjustment of energy tariffs and tariff structures j) Resolution of complaints and disputes between parties over any matter in the energy sector k) Prosecution of offences created under the Energy Act l) Certification of electrical workers and contractors, solar system installation technicians and contractors	**2. County energy regulation** a) Regulation and licensing of retail supply of coal products for domestic uses b) Regulation and licensing of biomass and charcoal producers, transporters and distributors c) Customise national codes for energy efficiency and conservation in buildings to local conditions d) Regulation and licensing of retail petroleum service stations e) Regulation and licensing of county gas reticulation systems f) Regulation and licensing of designated parking for petroleum tankers g) Regulation and licensing of biogas systems
Energy operations and development	
3. National energy operations and development a) Generation importation and exportation of coal, geothermal and other energy based natural resources b) Transportation and storage of coal c) Generation, transmission, distribution (including reticulation) and retail of electrical energy d) Collect and maintain energy data e) Implementation of the rural electrification programme and management of the rural electrification programme fund f) Undertake feasibility studies and maintain data with a view to availing the same to developers of energy resources and infrastructure g) Provide technical and other capacity building support to county governments h) Administration and management of the Sovereign Wealth Fund, the Consolidated Energy Fund and the National Energy Conservation Fund i) Providing security for energy infrastructure including power plants, control centres, electric supply lines and substations	**3. County energy operations and development** a) Electricity and gas reticulation b) Provide and maintain adequate street lighting c) Collect and maintain energy data d) Implementation of county electrification projects e) Undertake feasibility studies and maintain data with a view to availing the same to developers of energy resources and infrastructure f) Establishment of energy centres for promotion of renewable energy technologies, energy efficiency and conservation g) Security of energy infrastructure (power plants, control centres, electric supply lines and substations) h) Undertake energy efficiency and conservation measures within the county

(Source: Republic of Kenya, 2019)

2.4 Renewable energy potential

2.4.1 National level

Kenya is leading the continent in renewable energy production and aims to attain a 100% green energy mix by 2030. It aims to do this with a mix of solar, wind, hydro and geothermal energy providing approximately 93% of the country's energy needs, and the remaining 7% being reached through use of biofuels. The Energy Act, 2019 instituted the development of RE resource maps of the country within 12 months after its enactment in March 2020, and more detailed studies are expected to be conducted in this regard. A summary of Kenya's renewable energy potential can be found in **Table 7**.

Table 7: Summary of Kenya's renewable energy potential

WIND Proven potential as high as 346 W/m^2 and wind speeds over 6m/s	**SOLAR** Relatively stable off grid PV market with insolation estimated at more than 23,000 tWh/year	**BIOMASS** Cogeneration using charcoal, wood fuel and agricultural waste. Total estimated generation is 193 MW
GEOTHERMAL Proven potential as high as 10,000 MW along key sites in the Rift Valley	**HYDROPOWER** Potential of 1,000 MW from small-scale hydropower plants	**BIOGAS** Potential to produce over 130 MW of power

(Source: Africa Oil and Power, 2020)

2.4.2 County level

Nakuru is endowed with resources that support renewable energy development and thus provide the fundamental potential for a clean energy transition. **Table 8** outlines the potential from different sources.

Table 8: RE potential in Nakuru County

Energy source	Description of resource potential	Resource potential in Nakuru County	Installed capacity, licenced and registered (EPRA, 2020)
Geothermal	Nakuru is located in the Great Rift Valley, where geomorphological processes allow for geothermal energy generation. Geothermal energy potential in the Rift Valley currently stands at 7,000 MW, according to the Ministry of Energy and Petroleum (UNDP, 2014). About 78% of this potential (i.e., 5,500 MW) is expected to be harnessed by 2030. Nakuru County alone has a capacity of 593 MW as of 2015, and the potential to tap into the geothermal space is huge, with a target of 5,000 MW by the year 2030.	10,000 MW	1115 MW
Biogas	This form of energy largely depends on biomass - organic material from plants and/or animals. In Kenya, biogas energy generation is still at low inception levels, which could be attributed to many factors such as costs, policy limitations, technology adoption, socio-cultural factors, among others of 2015, the unknown potential exists for the government and private entities. The county targets 50 MW capacity by 2030.	Unknown	2.6 MW

Energy source	Description of resource potential	Resource potential in Nakuru County	Installed capacity, licenced and registered (EPRA, 2020)
Solar power	Nakuru County receives long hours of sunshine each day. The potential for solar energy in Nakuru County remains high but is under-tapped, even though there are increasing solar panel installations. Nakuru County has the potential to generate about 7.4 kWh/m^2/day of solar energy and aims to generate about 200 MW from solar energy by 2030 (CCEAP 2018–2023).	7.4 kWh/m^2/day	1
Wind power	Nakuru County has a maximum annual mean wind speed of 6.52 m/s, only second to Turkana with a maximum of 7.11 m/s. A study commissioned by the Ministry of Energy has classified wind speed for Nakuru as class IV, measured at the height of 100 m. Although not classified as a major wind hotspot area for Kenya, Nakuru County is a viable place to generate wind energy to supplement Kenya's energy mix. Premised on the current capacity and the county's potential, Nakuru county aims to generate 100 MW from wind energy by 2030.	29,286 km^2 with average speeds of 6.52m/s	Unknown
Hydropower	This is the most viable and common energy generation model, contributing over 40% to the national grid (CCEAP 2018–2023). With the climate variability and change, energy production from hydro sources is expected to fluctuate. For Nakuru, which was generating 34.4 MW from hydro sources, the potential is expected to drop drastically to 15 MW due to reduced rainfall in the region.	34.4 MW	Unknown

(Source: County Government of Nakuru, 2015)

3. Data collection strategy

The data required to conduct the Access to Energy Assessment for Nakuru County was obtained in two main phases: a detailed desktop review (secondary data collection); as well as through household surveys and discussions (primary data collection) with various stakeholders such as representatives from the Ministry of Energy, Energy and Petroleum Regulatory Authority (EPRA), Kenya Power and Lighting Company (KPLC), and representatives from the county's Department of Energy, Environment and Water Resources. The data collected was guided by the requirements of the Joint Research Centre (JRC) guidelines for the development of the Access to Energy pillar of the Sustainable Energy Access and Climate Action Plan (SEACAP) which Nakuru County, as a CoM SSA signatory, has committed to developing. Outlined below are the steps and approach used for data collection.

3.1 Secondary data collection

The very first step of the data collection process was undertaking an in-depth review of peer reviewed literature to extract information required to (1) fill the data requirements of the JRC templates and (2) guide the primary data collection process and/or identify key stakeholders that need to be contacted to collect data. Electricity demand and supply information, including generation mini-grids, were sourced from the KPLC, EPRA, and the Ministry of Energy. National and county-level policies, strategies, and assessments were also reviewed to retrieve information and data relevant to Nakuru County. A list of the resources consulted as well as the meetings and consultations held with stakeholders have been outlined in Annex 2 of this report.

3.2 Primary data collection

Household primary data collection was used to fill in the gaps in information not found during the secondary data collection. A digital questionnaire was developed using Kobo toolbox[1], covering aspects of household demographics, income, access to electricity, access to clean cooking, willingness to transition to clean cooking and other challenges faced by the household with respect to sustainable, secure and affordable access to energy. The questionnaire was administered through telephone interviews due to the restrictions posed by the Covid-19 pandemic. The questions used have been added to Annex 3 of this report.

In order to determine an appropriate primary data collection methodology, sampling strategy and sample size, consultative meetings were held with various stakeholders at both the national and county level. Such stakeholders included: Nakuru County government, national government stakeholders (Nakuru KPLC office and the Kenya Bureau of Statistics – Nakuru office), civil society (World Vision and Sustainable Community Development Services (SCODE), a community-based organisation working on energy issues in the area). Feedback from these stakeholders guided the sampling methodology and sample size used (see Section 3.2.1 below).

3.2.1 Sample size

Slovin's formula (see Equation 1) was used to determine the appropriate sample size for data collection. Nakuru County has 11 subcounties with a total of 616,046 households. The household population was incorporated into Slovin's formula in order to obtain a statistically accurate sample of the household population to be interviewed. A sample size of 400 was arrived at against the total household population within a confidence limit of 95%, and an error margin of 0.05. Further to this, 20 additional households were also selected for piloting the household data collection process, bringing the total sample to 420 households.

$$n = N / (1+Ne^2)$$ _____ [Equation 1]

Where:

n = sample size; N = population size; e = error margin

[1] KoBo Toolbox is a free open-source tool for mobile data collection, available to all. It allows researchers to collect data in the field using mobile devices such as mobile phones or tablets, as well as with paper or computers.

3.2.2 Sampling technique

The stratified random sampling technique was adopted and designed to capture the physical and socio-economic diversity of the county. A stratified random sample is one obtained by dividing the population elements into mutually exclusive, non-overlapping groups of sample units called strata, then selecting a simple random sample from within each stratum (Steidl, n.d.).

This method was chosen as appropriate for the household primary data collection in Nakuru County because of the heterogeneity in the county with respect to income level, rural/urban divide, variability of grid transmission lines amongst other factors. As such, the different strata were defined according to the following variations:

- Geography: Each of the 11 subcounties within Nakuru County represented a strata.
- Wealth ranking: This was also based on the Kenya National Bureau of Statistics' (KNBS) categorisation of subcounties into urban and rural.
- Gender: Samples were drawn from both male and female-headed households.

Below is a distribution of the households contacted for data collection from the different subcounties.

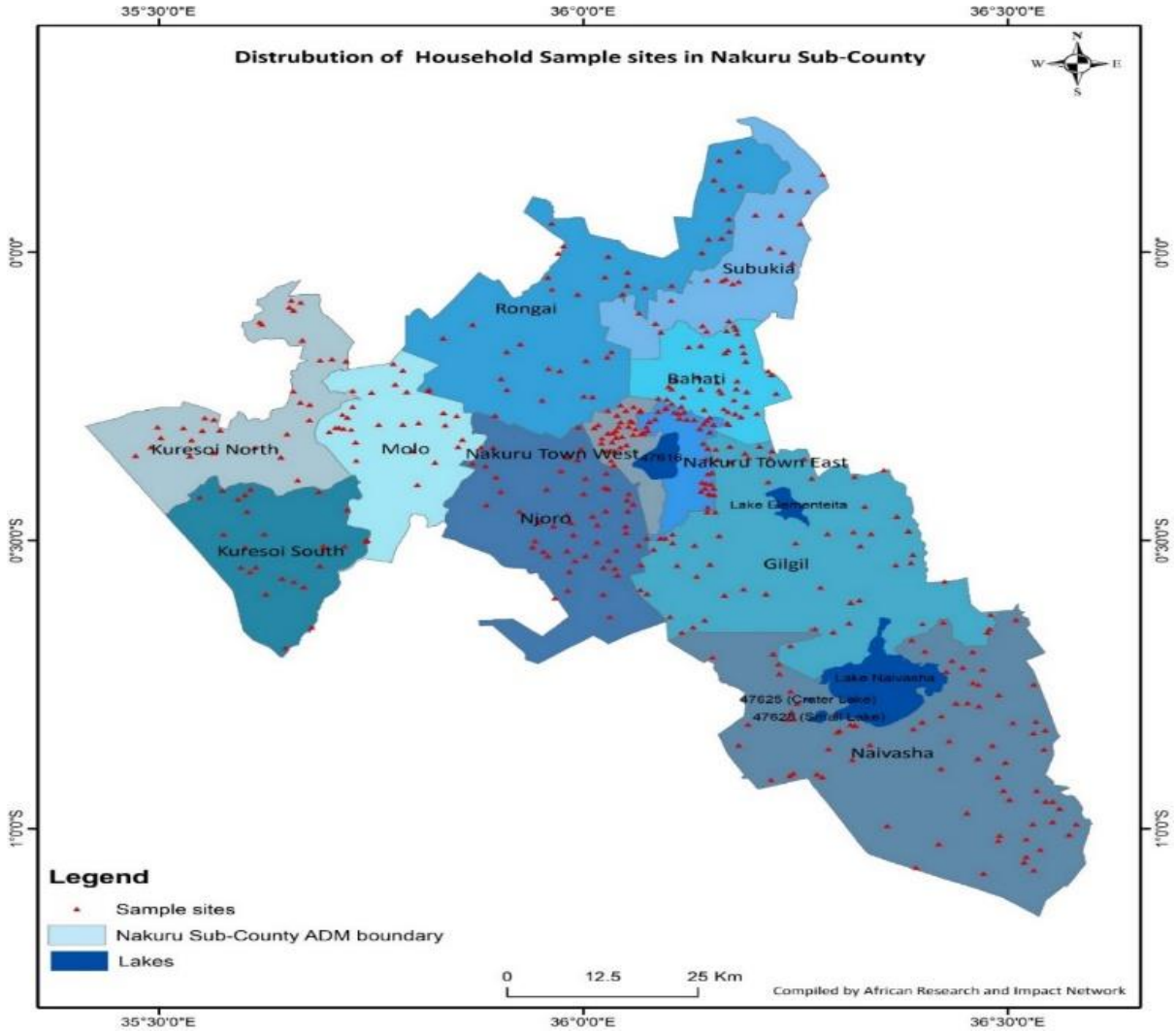


Figure 3: Household random distribution sample sites in Nakuru subcounties

3.2.3 Steps used in primary data collection

The phone numbers of the 420 households were acquired and verified through the subcounty officers of the County Government of Nakuru. Twelve enumerators were taken through a two-day face-to-face training course covering the overall objective and scope of the SEACAP, the questionnaire, the use of the Kobo-toolbox, and general ethics in engaging households through phone interviews.

Pilot interviews were executed with a sample of twenty households during the training session, allowing for testing of the tool's effectiveness, and modifying it where needed. The actual data collection then commenced two days after the training; the Kobo-tool box used allowed for real-time monitoring of the data collection process. The interviews were audio-recorded and stored as part of the study's database used to verify and authenticate the information recorded in the toolbox. Data were analysed using GIS, (for spatial representation of the data) and MS Excel (for quantitative and qualitative analysis of the data). **Figure 4** is a summary of the steps used in the primary data collection process.

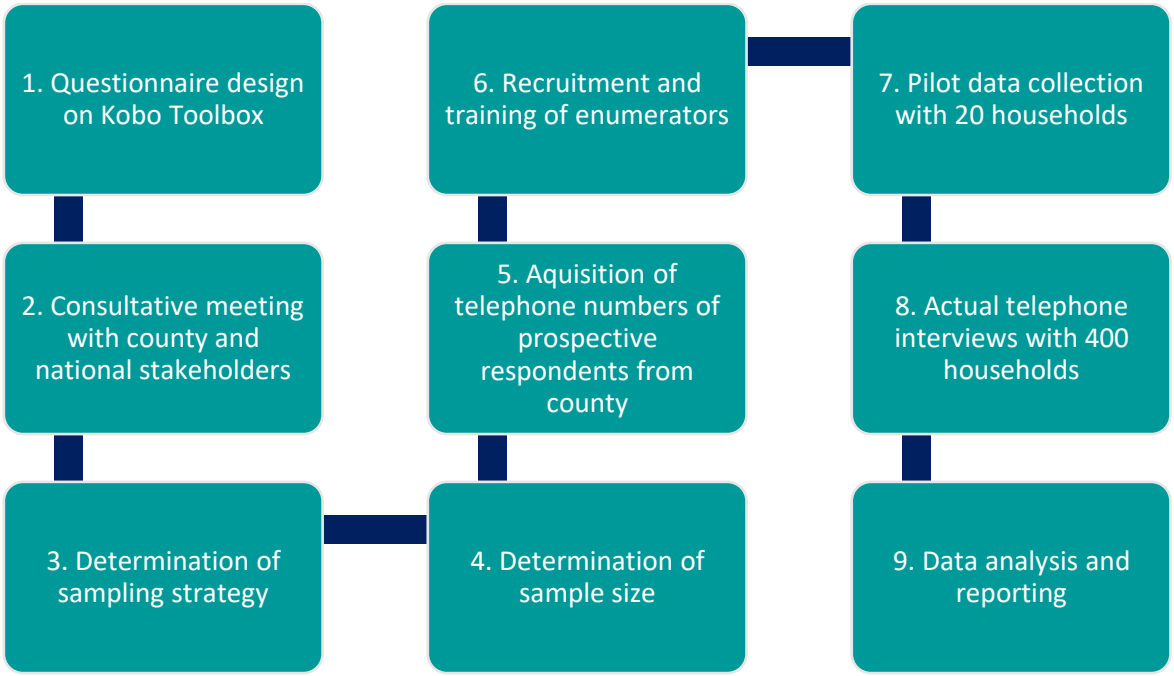


Figure 4: Summary of steps used during primary data collection in Nakuru County

The next section presents the findings of the data collection process, particularly with respect to access to electricity and access to clean cooking in households in Nakuru County. The analysis also goes beyond the scope of indicators used in the SEACAP and presents key and holistic insights that will enable the county achieve its energy access vision and targets.

4. Results

This section presents the results following the analysis from the data collected through the household surveys. The findings portray the household characteristics, access to electricity, access to clean cooking, and to an extent, energy poverty in households within the county.

4.1 Household characteristics

During the primary data collection process, 420 people were interviewed, 56% of which were men and 44% women, mostly within the age brackets of 35 and 44 years, with most households headed[2] by the father (67% of households) as illustrated in **Table 9**. The majority of those interviewed had a secondary education, implying desirable literacy levels and extensive knowledge about the household characteristics.

Table 9: Demographic characteristics of the households interviewed

Education level of respondent	
Pre-school	2%
Primary	26%
Secondary	44%
Tertiary	29%

Age group of respondents	
Age group (years)	Percentage
<65	5%
18-24	4%
25-34	21%
35-44	30%
45-54	24%
55-64	17%

Household main Earner	
Main earner	% of households
Father	67%
Mother	25%
Child	7%
Both parents	2%
Don't know	0.80%

The analysis shows that main earners in the households are mostly the fathers (in 66.4% of households) and then mothers (in 24.8% of the households), a child (6.2%) and others (2.6%). The income range of most households is between KES 6,000 and 15,000, with a very small percentage (3%) of households earning above KES 66,000 a month, as illustrated in **Figure 5**. The majority of households fell at or below the poverty line.

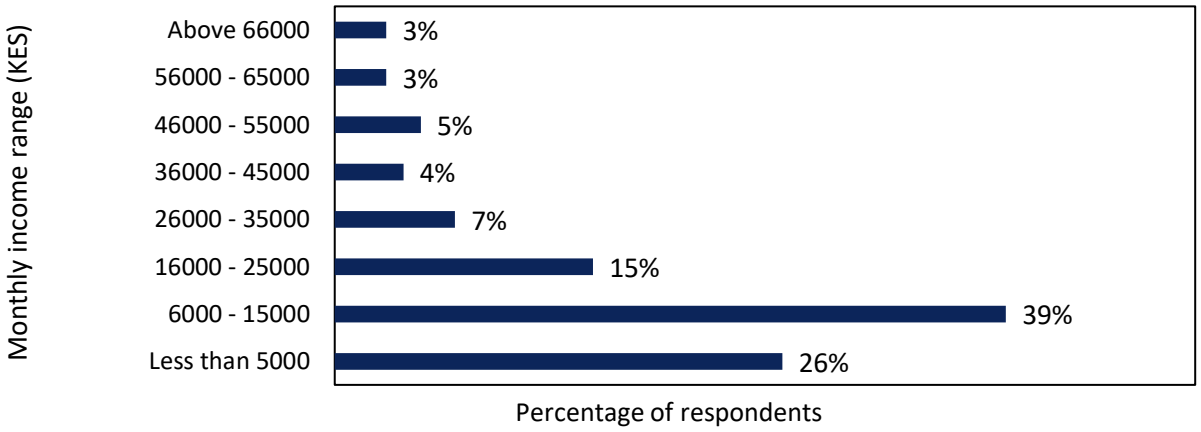


Figure 5: Household income range

Similar to most cities in sub-Saharan Africa, the majority of the households (36%) in the county depend on farming as their major source of income as shown in **Figure 6**. Many households also rely on small businesses and informal sources of income, with just a small percentage (12%) relying on formal employment. In this report, casual employment also known as informal employment refers to those whose payments are irregular and thus inconsistent and cannot be predicted. The reliance on farming and casual/informal sources of income deepens the risk that could be posed by negative environmental, climatic and financial changes within the county.

[2] In this report, household head refers to the main earner in the household.

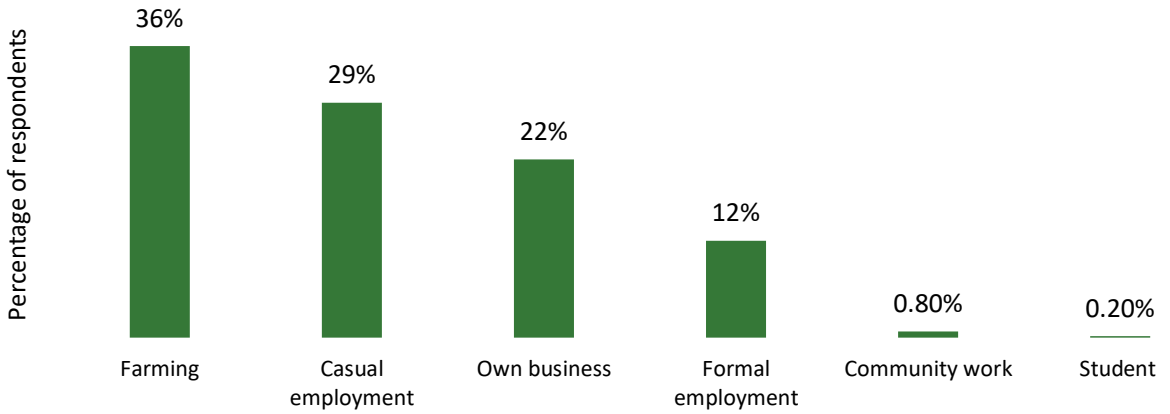


Figure 6: Sources of household income

4.2 Access to electricity in households

According to the definition by the International Energy Agency, electricity access refers to the percentage of people in a given area that have relatively simple, stable access to electricity (IEA, 2020). It is worth noting that there is no universally acceptable definition of energy access, and in this study, electricity access refers to those actually using electricity in their households, no matter the reliability, sustainability, affordability, quality and source (on/off-grid) of the supply. The Kenyan 2019 population and housing census revealed that 64.4% of households in Nakuru County use electricity as the main power source of lighting, compared to 50.4% at the national level (88.4% of this represents urban electrification and 26.3% rural electrification) (KNBS, 2019c).

This assessment through the SEACAP process disaggregated electricity access data based on availability (of different fuel types in the area) and usage (of the different fuel types). Analysing the data showed that 87.6% of respondents had electricity available in their area.

Of the total population, only 63.8% actually use electricity in their households. The remaining 36.2% not using electricity in their households provided a number of reasons for this, as illustrated in **Figure 7**. Unavailability of gridlines in the area and distance from the transformer were cited as the main reasons. Other households not using electricity also mentioned that they were unaware of the connection process, while some mentioned the delay in the connection process as a reason for not using electricity. It is however remarkable to note that 98.7% of those not using electricity in their households are willing to use it if barriers for use are removed. A number of actions need to be taken to enhance connectivity for households far from the grid or transformers, mainly through the use of distributed mini-grids or solar home systems.

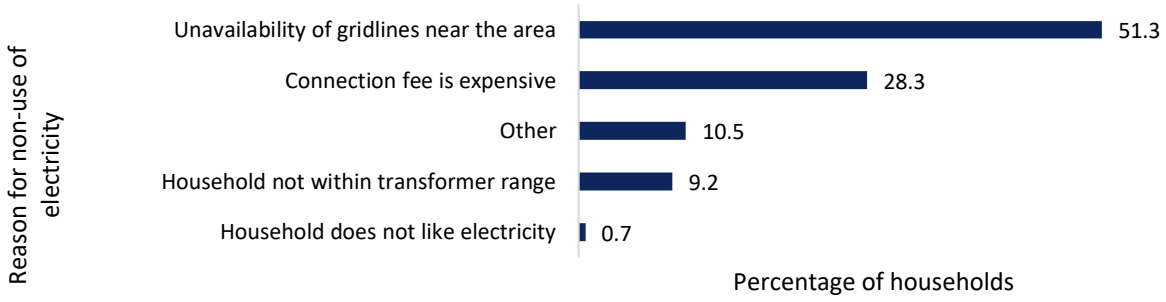


Figure 7: Factors hindering use of electricity in households

Analysing the source of electricity used in households showed that 95.5% of households using electricity access it through the national electricity grid (KPLC), while 4.5% obtain it from a local mini-grid or solar home system. Furthermore, of households using electricity, 88.1% have their own electricity meters, while 10.8% share a meter and 1.1% use extension cords from other sources. Residents not using electricity in their households use other fuel substitutes such as candles, firewood, generators, and rechargeable torches amongst others, for lighting, cooking, heating and cooling their homes.

4.2.1 Electrification rate according to subcounty

Households using electricity in the county (63.8%) vary across the eleven subcounties, with the use of electricity generally high in the urban subcounties such as Nakuru West (97.6%), Nakuru East (97.1%) and Naivasha (86.8%). Similarly, the peri-urban subcounties such as Subukia, Njoro, Gilgil, and Molo also have high electricity usage rates at 68%, 69.2%, 59.3% and 66.7%, respectively. However, usage rates are low for more rural subcounties such as Kuresoi South (24.1%) and Kuresoi North (28.6%). This provides insights on where the Last Mile Connectivity Program in the county could be directed. There is a need for interventions that could support connectivity in rural areas if the county is to achieve 100% electrification by 2030. It is also interesting to note the gap between availability and usage of electricity in subcounties like Bahati and Kuresoi North and South, where the most probable reason for low access rates could be that of affordability of electricity.

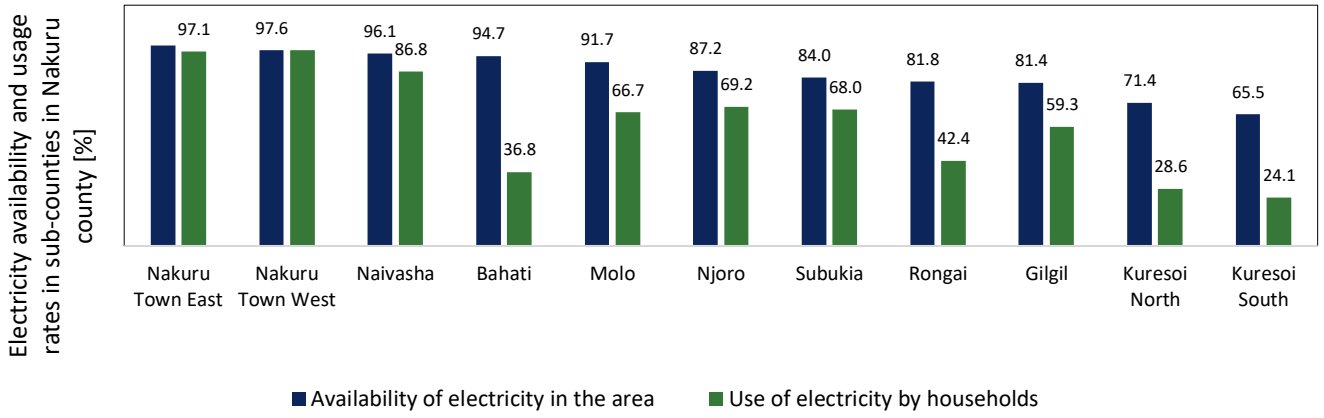


Figure 8: Percentage of electricity availability and usage per subcounty

4.2.2 Electrification rate as a function of household head

The analysis showed a slight disparity in electrification rates amongst the main earners in the household (household head). The electrification rate of female- and male-headed households is roughly the same as shown in **Figure 9**. As per the data, households with main earners labelled as "other" include responses such as: combined family resources, not yet a parent, older sister, living alone, both balance, both father and mother, etc.

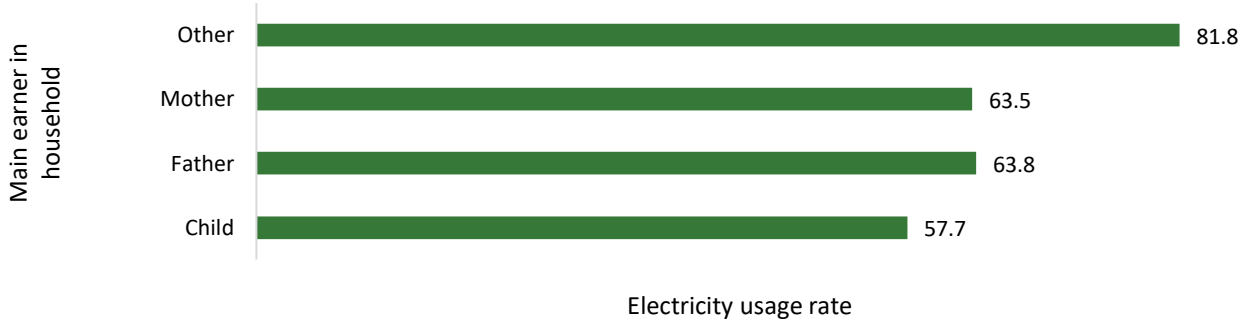


Figure 9: Access to electricity as a function of household head

4.2.3 Different uses of electricity

Those with electricity in their households mostly use it for lighting (99.6%) as shown in **Figure 10**. In addition, it is also used for cooking (7.1%), heating (12.7%) and cooling (7.8%).

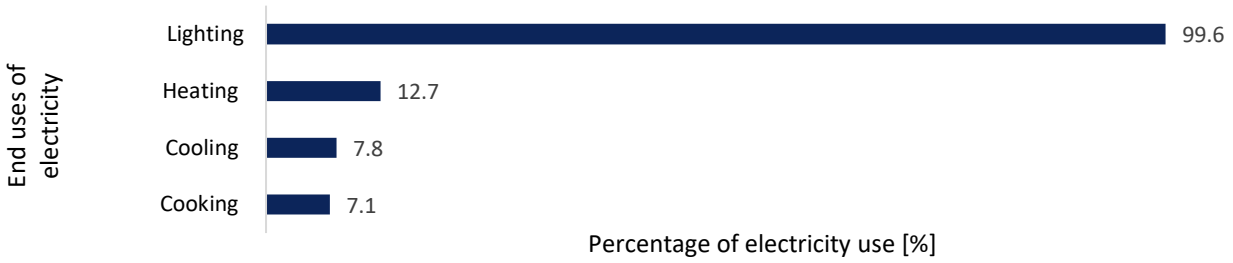


Figure 10: The different uses of electricity in households

Even though electricity is used for various purposes, the frequency of usage can be very limited as illustrated in **Figure 11**, with 31.6% of respondents using electricity just once a month to cook for instance, while it is used for cooling, heating and lighting on a daily basis by most respondents (61.9%, 50% and 100% respectively). The household survey indicated that the limited use and low usage frequency of electricity for other services like cooking, heating and cooling is likely due to the availability of other more readily available and affordable substitutes such as biomass, LPG and paraffin, as will be discussed in subsequent sections.

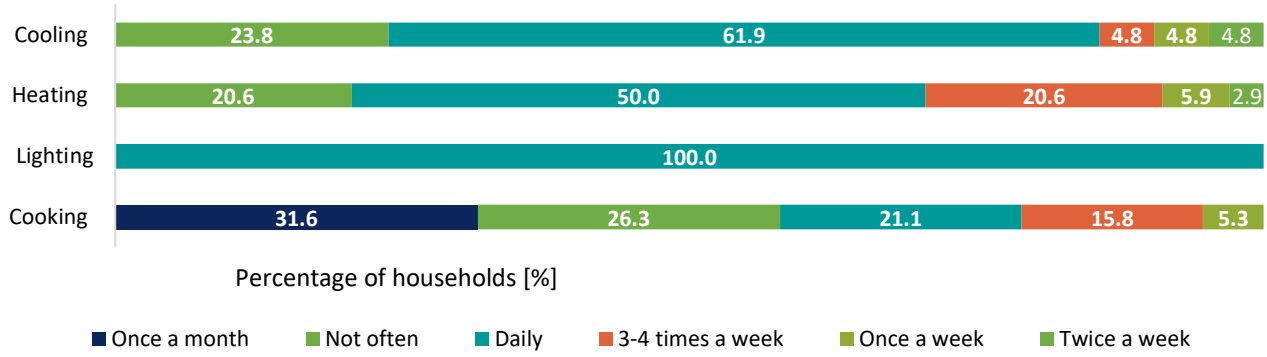


Figure 11: Frequency of use of electricity for various purposes in the household

The survey also assessed the use of different appliances by households in the county as summarised in **Table 12**. While most households have one of the appliances available in the household, there are an average of two smartphones per household. The prevalence of radio sets could be due to the fact that the radios can use chargeable batteries or even non-chargeable batteries with little or no reliance on electricity. This also shows that text messages and radio stations could be a possible way of disseminating information about energy access in the county. The availability of basic appliances like radios, TV sets, pressing irons and gadgets like smartphones and laptops are common in the county. However, high wattage appliances such as electric kettles, microwaves, dishwashers, washing machines and electric heaters or fans are only available in very limited amounts. The lack of such heavily consuming appliances could be due to the unreliability of the electricity supply, high electricity cost, and high cost of appliances, or the unavailability of such appliances in the county. It is important to note that access to energy goes beyond the use or non-use of electricity in the household to also examine what the electricity is actually used for.

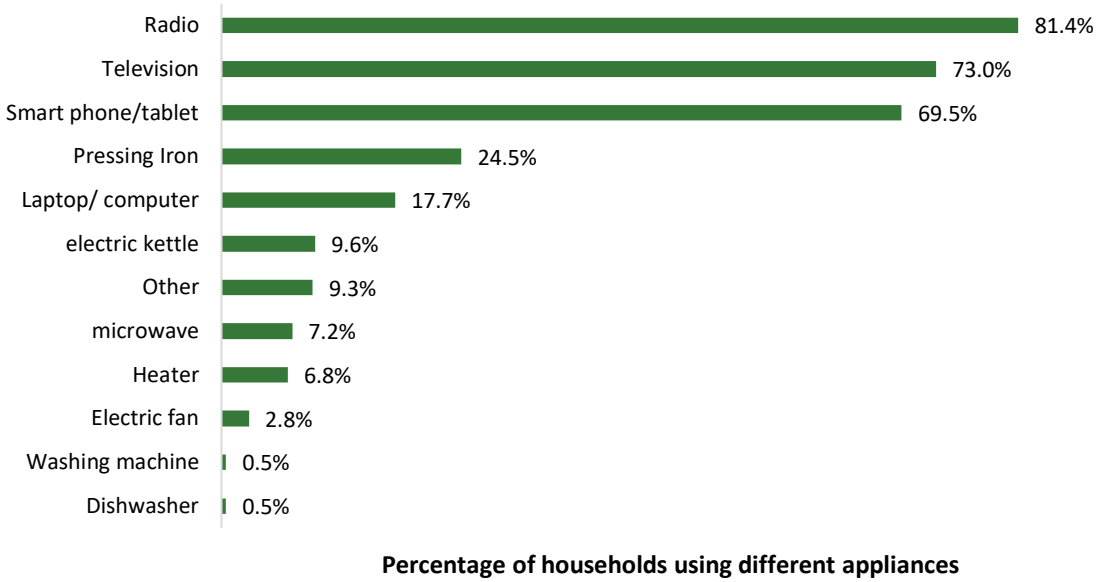


Figure 12: Percentage of households using different appliances

4.2.4 Reasons for choosing electricity over substitutes

The survey further explored the main reasons for the use of electricity as depicted in **Figure 13**. These are availability, affordability and safety. Those using electricity are already able to see the benefits compared to substitutes, and the focus now should be on increasing electricity availability to unserved or underserved communities.

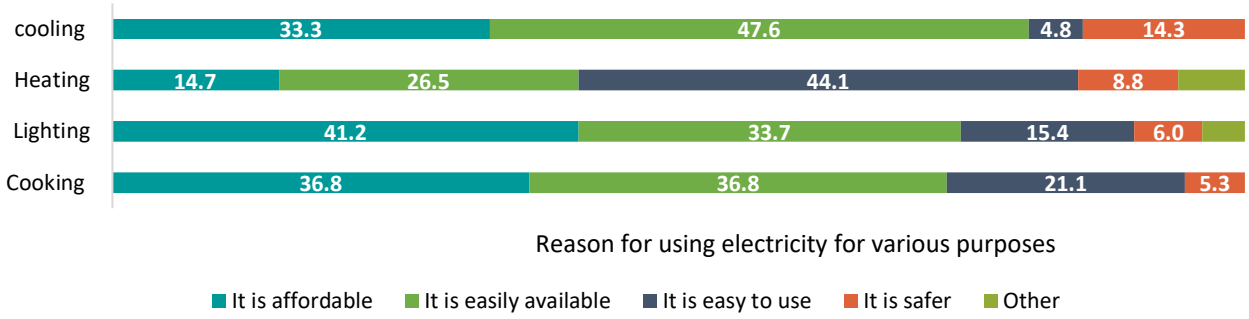


Figure 13: Reasons for choosing electricity over substitutes, for different uses

4.2.5 Method of payment for electricity

This survey explored various options used by households to pay for electricity. It found that most households using electricity use pre-paid meters (60.8%) followed by post-paid (37.7%) as shown in Table 4.2. There is a very small percentage (1.1%) who pay private people and 0.4% who get it free. Households claiming to get electricity for free could possibly be obtaining it through relatives or friends as there is currently no existing scheme providing free electricity to households in the county[3]. The preference of prepaid options for electricity could also be applied to other sectors, especially clean cooking solutions in the county.

[3] Based on discussion with key informants at county government.

Table 10: Methods of payment for electricity by households

Method of payment of electricity	Percentage
Pre-paid meter	60.8
Post paid	37.7
I pay a private person	1.1
I get it free	0.4

4.2.6 Frequency of buying electricity and monthly spending on electricity

In terms of frequency of electricity purchase, 56.4% stated that they bought electricity monthly, 20.9% buy only when they can afford it, and 5.5% and 17.2% buy on a daily and weekly basis, respectively. The purchasing power is largely defined by income levels and source of income. The amount of money spent each month on electricity also varies with the household head (main earner), with female-headed households spending an average of KES 13,16.70 per month compared to KES 1,070.70 per household per month for male-headed households as shown in **Table 11**. On average, households in Nakuru County spend KES 1,653.10 per month on electricity with a minimum of KES 50.00 and a maximum of KES 8,000 per month. Also, based on average household income in the county, households spend an average of 6% of their monthly income on electricity bills.

Table 11: Frequency of buying electricity and average monthly spending on electricity

How often do you buy electricity?	Percentage
Monthly	56.4
I buy when I can afford it	20.9
Weekly	17.2
Daily	5.5

Household head (main earner)	Amount of money [KSH] spent per month per household on electricity as a function of household head
Other	3250.0
Mother	1316.7
Father	1070.7
Child	975.0

4.2.7 Affordability of electricity

There is no straightforward approach to estimating the affordability of electricity. In this assessment, a number of approaches could be used to estimate the percentage of households able to pay for electricity. This could range from a high-level approach that considers just the percentage not using electricity due to its cost; to the actual percentage of household income spent on electricity. For this study, it was found that, of those not using electricity, 28.3% have electricity available in their area, but are not using it because it is too expensive. In this case, a simplistic approach could be used to say 71.7% of Nakuru County are able to afford electricity. However, there are some households that actually use electricity, but have experienced a suspension in the electricity supply because they were unable to pay the electricity bills (50.5% of households using electricity). It is also worth noting that this does not entirely correlate to the percentage of households able to pay for electricity, but depicts the percentage of households struggling to pay their electricity bills.

Furthermore, electricity affordability could also be assessed by the percentage of households' income being spent on electricity. In this assessment, this is not the most appropriate approach as household income was provided in terms of ranges, hence an average for the range was used to estimate the household income. Households in Nakuru County spend an average of 6% of their monthly income on electricity. It is interesting to see that those earning less than KES 5,000 spend the most significant proportion of their income on electricity (13%) compared to those earning more (see **Figure 14**).

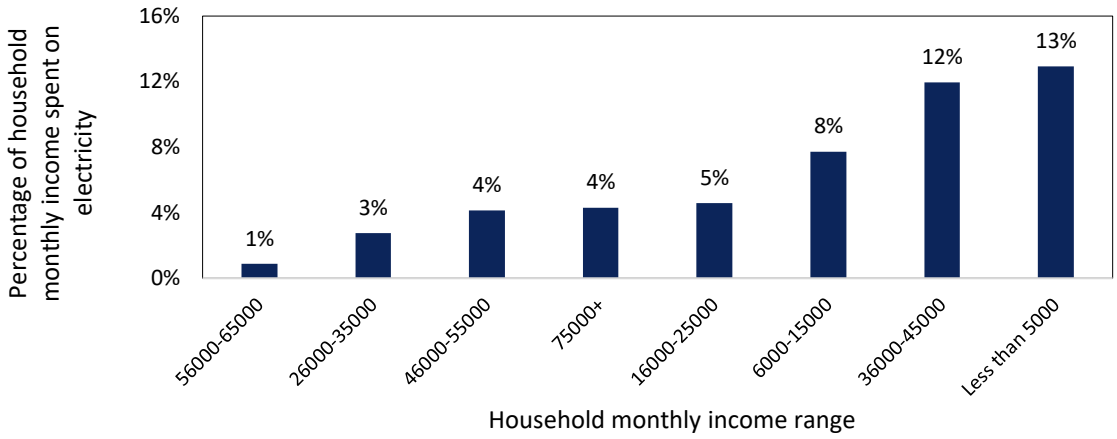


Figure 14: Percentage of household monthly income spent on electricity

4.2.8 Reliability of electricity supply

The survey also assessed the reliability of the electricity supply. 62% of the survey respondents using electricity in their households acknowledged they had experienced a power outage. The power outage rate in Nakuru averages about 3.76 hours a day, leaving only 20.24 hours in a day with electricity (Maende & Alwanga, 2020).

4.3 Access to clean cooking

Access to clean cooking facilities means "access to (and primary use of) modern fuels and technologies, including natural gas, liquefied petroleum gas (LPG), electricity and biogas, or improved biomass cook-stoves (ICS), as opposed to the basic biomass cook-stoves and three-stone fires" (JRC, 2018). Cookstoves are commonly called "improved" if they are more efficient, emit less or are safer than the traditional cookstoves or three-stone fires.

Despite the well-documented benefits of clean cookstoves, about 3 billion of the world's population still use polluting, inefficient cooking solutions that emit toxic pollutants to the environment. The inefficient use and incomplete combustion of solid fuels have significant impacts on health, socioeconomic development, gender equality, education, and climate (Ekouevi & Tuntivate, 2012; UNDP & WHO, 2009). Fuel collection and cooking tasks are often carried out by women and girls, and the time spent collecting depends on the local availability of fuel, which might reach up to several hours per day. This often translates into lost opportunities for gaining education and increasing income (Blackden and Wodon, 2006; Clancy, Skutch, and Batchelor 2003).

Kenya has made notable efforts in encouraging the use of clean and improved cookstoves. According to the Energy Sector Management Assistance Program – Multitier Framework (ESMAP MTF) survey results (2018), over 65% of households still use traditional biomass stoves and fuels to address their primary cooking needs. Hence, this assessment explores the various fuels used for cooking, frequency of use, reason for use and expenditure on each fuel type, as explained in the following sections.

4.3.1 Primary cooking methods used

The use of biomass for cooking is prevalent in Nakuru County, with 46.4% of households relying on three-stone firesides as the primary method of cooking, followed by a reliance on gas stoves or LPG (29.3%), and traditional *jikos* (19%) as illustrated in **Figure 15**. *Jiko* is an African word for the traditional cooker. A *jiko*/geo-cooker stove (which either uses charcoal or wood as fuel) burns much more efficiently as less heat escapes, thus cutting the consumption of wood in half (Nasio Trust, n.d.).

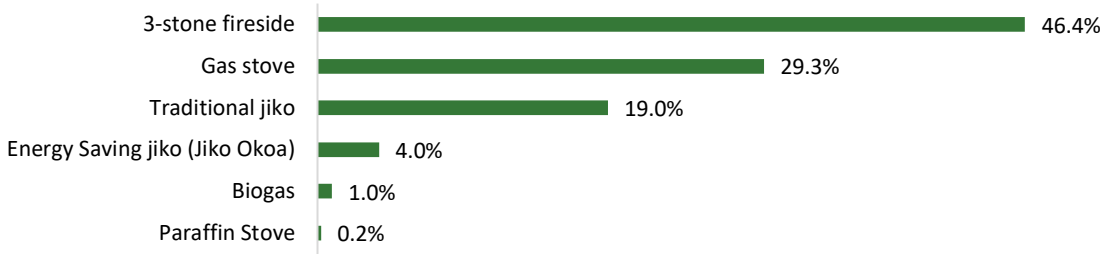


Figure 15: Primary methods of cooking

Table 12 further disaggregates the primary cooking methods in Nakuru County by subcounty. It is evident that the use of three-stone firesides as the primary cooking method is more prevalent in rural areas of the county such as Kuresoi North (90.5% of households) and Kuresoi South (96.6%), whereas in urban areas like Naivaisha, Nakuru East and Nakuru West, the use of three-stone firesides as the primary cooking method is relatively minimal (27.3%, 8.8% and 9.8% of households respectively). The dominant method used in such urban areas is cooking by gas stove (49.4% in Naivasha, 61.8% in Nakuru East and 58.5% in Nakuru West). The use of traditional *jikos* is very common and significantly used across all subcounties. This means that households are somewhat familiar and comfortable with the affordability, convenience and safety of such stoves; hence actions to improve the efficiency and reduce the environmental impacts of traditional *jikos* will facilitate a transition to improved cookstoves and clean cooking methods in the county.

Furthermore, the subcounties primarily relying on clean cooking are dominated by those in urban areas: Naivasha (55.8%), Nakuru West (61%) and Nakuru East (64.7%), while rural subcounties like Kuresoi North and South rely heavily on the use of traditional biomass, with just a 4.8% and 3.4% primary reliance on clean cooking respectively.

Table 12: Primary methods of cooking disaggregated by subcounty

Sub-county	3-stone fireside [%]	Jiko (Traditional) [%]	Paraffin [%]	Energy-saving Jiko [%]	Gas Stove [%]	Biogas [%]
Bahati	52.6	21.1	0.0	5.3	18.4	2.6
Gilgil	55.9	25.4	0.0	3.4	15.3	0.0
Kuresoi North	90.5	4.8	0.0	4.8	0.0	0.0
Kuresoi South	96.6	0.0	0.0	0.0	0.0	3.4
Molo	45.8	25.0	0.0	0.0	29.2	0.0
Naivasha	27.3	16.9	0.0	5.2	49.4	1.3
Nakuru Town East	8.8	26.5	0.0	2.9	61.8	0.0
Nakuru Town West	9.8	26.8	2.4	2.4	58.5	0.0
Njoro	56.4	15.4	0.0	7.7	17.9	2.6
Rongai	54.5	15.2	0.0	9.1	21.2	0.0
Subukia	64.0	24.0	0.0	0.0	12.0	0.0
Grand Total	**46.4**	**19.0**	**0.2**	**4.0**	**29.3**	**1.0**

Sub-county	Percentage primarily relying on clean cooking [%]
Kuresoi South	3.4
Kuresoi North	4.8
Subukia	12.0
Gilgil	18.6
Bahati	26.3
Njoro	28.2
Molo	29.2
Rongai	30.3
Naivasha	55.8
Nakuru Town West	61.0
Nakuru Town East	64.7

4.3.2 Primary cooking method as a function of household head

The correlation between the primary method of cooking and the household head (main earner) was also explored. The analysis showed that 66.4% and 24.8% of households in Nakuru County are headed by men and women respectively, while the rest are headed by children and others (6.2% and 2.6% respectively). The use of three-stone firesides is prevalent across all households regardless of who they are headed by. However, the use of solid biomass as the primary cooking method is more prevalent in female-headed households, with 51% using three-stone firesides, 30.8% using traditional *jikos*, and 1% using paraffin. On the other hand, as shown in **Figure 16**, the use of cleaner cooking methods such as LPG (33.8%), biogas (1.4%), and energy-saving *jikos* (5%) are more common in male-headed households.

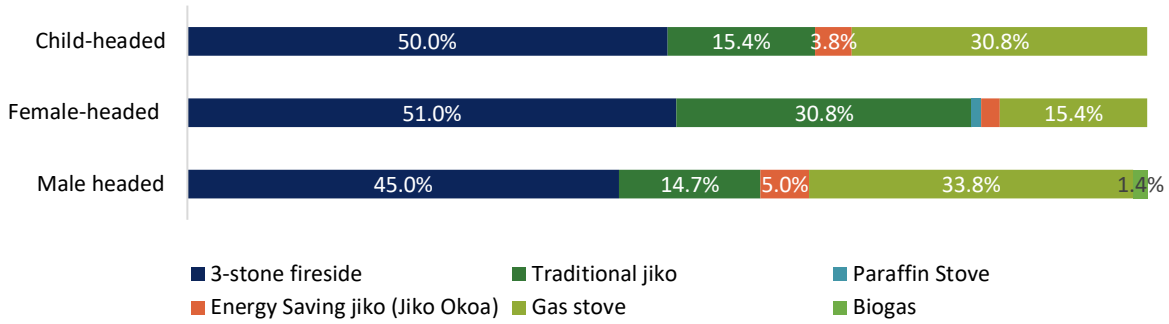


Figure 16: Primary fuel used for cooking as a function of household head (main earner)

Since LPG, biogas and energy-saving *jiko* stoves are considered to be clean cooking methods, it can be concluded that 40.3% of male-headed households predominantly use clean cooking methods while only 17.3% of female-headed and 34.6% of child-headed households predominantly use clean cooking methods, as shown in **Figure 17**.

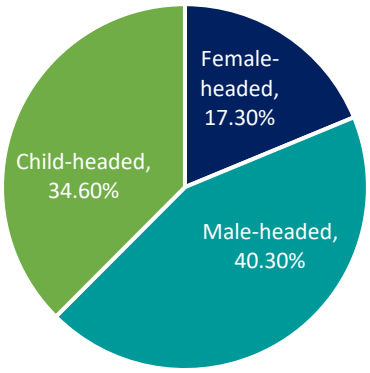


Figure 17: Use of clean cooking methods as a function of household head

4.3.3 Cookstove stacking

The use of secondary and even tertiary cooking methods/stoves (cookstove stacking) in Nakuru County is highly prevalent, with almost all households using more than one stove type for cooking. Fuel/stove stacking in Nakuru County is motivated by several factors, amongst which are cost, convenience, ease of access, and household preferences. The most common secondary fuel used for cooking in Nakuru is the traditional *jiko*, at 50.4%, followed by gas stove (LPG), three-stone fireside, paraffin stove, energy-saving *jiko*, electric stove, and biogas at 23.5%, 20.1%, 5.8%, 3.7%, 2.6%, and 0.9% respectively. The use of other methods such as electric coils (0.23%), electric pressure cookers, firewood and a combination of stoves were also present and accounted for 8.2% of the secondary stoves used for cooking.

Furthermore, of those using three-stone firesides as primary methods, 46.7% of them use traditional *jikos* as secondary methods while 12.8% use gas stoves and 11.8% still use three-stone fires as secondary fuels. The remaining 28% use a combination of other options. There is also a higher tendency for households using cleaner methods like energy-saving *jikos* and gas stoves to use relatively clean secondary cooking stoves. As illustrated in **Figure 18**, households using gas stoves as primary fuels mostly use traditional *jikos* (52.0%) as secondary stoves, while those using energy-saving *jikos* as primary stoves mostly use gas stoves as secondary cookstoves. Also, a number of households use a combination of stoves as secondary stoves, e.g. gas stoves and three-stone firesides. Hence, in a quest to enhance a transition to clean cooking options, it is equally important to put in place measures that will reduce the tendency to rely on secondary cooking options that are not clean.

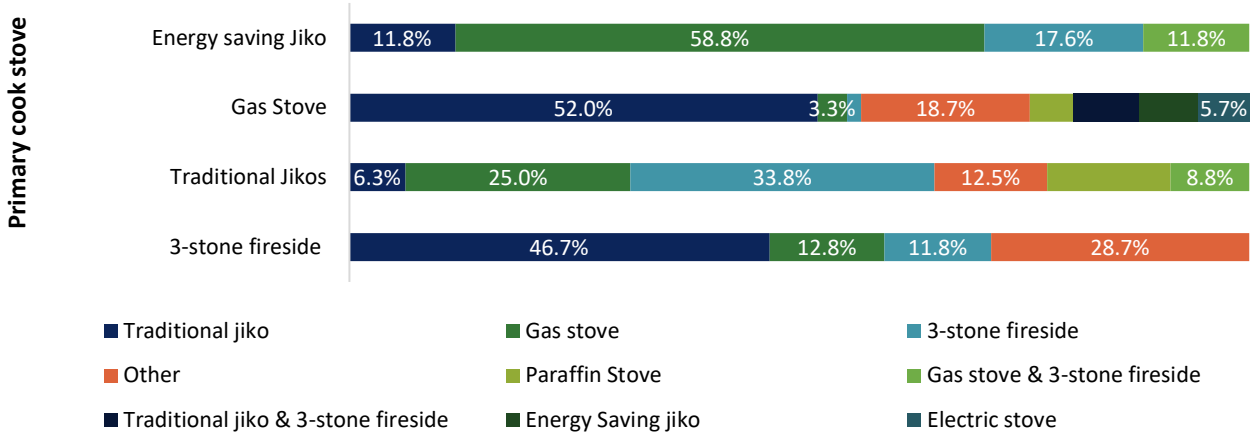


Figure 18: Secondary stove types used by households as a function of primary cookstove

4.3.4 Willingness to transition to clean cooking

The assessment also interrogated the preference of cooking methods in Nakuru County. Almost all households (97%) are willing to transition to clean cooking options. Over 88.3% of households mentioned that they would actually prefer using clean cooking options (LPG, biogas and electricity) for cooking if they had a choice, as shown in **Figure 19**. About 16.9% of households prefer biogas for cooking while paraffin, firewood, and traditional *jikos* are less preferred, even though they are currently common. Despite these preferences, many factors including accessibility, convenience, availability and affordability, determine households' ability to adopt them. Nonetheless, the willingness of households to embrace clean cooking options is an opportunity for the county to adopt interventions that address underlying socio-economic and political factors impeding the ability to access these clean options.

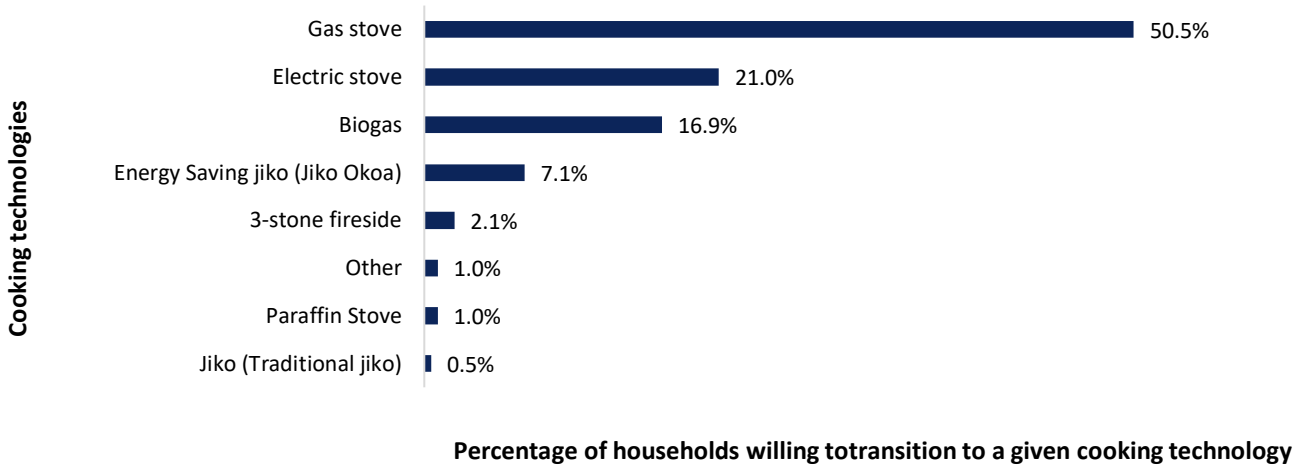


Figure 19: Preferred clean cooking options

Since there are costs associated with the transition, the assessment further explored the households' readiness to spend towards the transition to clean cooking methods. About 56% of the household were willing to spend an amount less than the current amount spent on fuel for cooking. Only 17.2% agreed to spend the current fuel cost on the transition, while 19.4% are willing to spend more than their current spending on fuels in order to transition to clean cooking. About 5% were reluctant to spend any amount of money on the clean cooking transition (see **Figure 20**). This reveals that the transition to clean cooking should be less costly to most households compared to their current expenditure on fuel and cookstoves. Also, it also means more awareness-raising campaigns are needed so that households can better understand the benefits of clean cooking which goes beyond the up-front cost of such technologies.

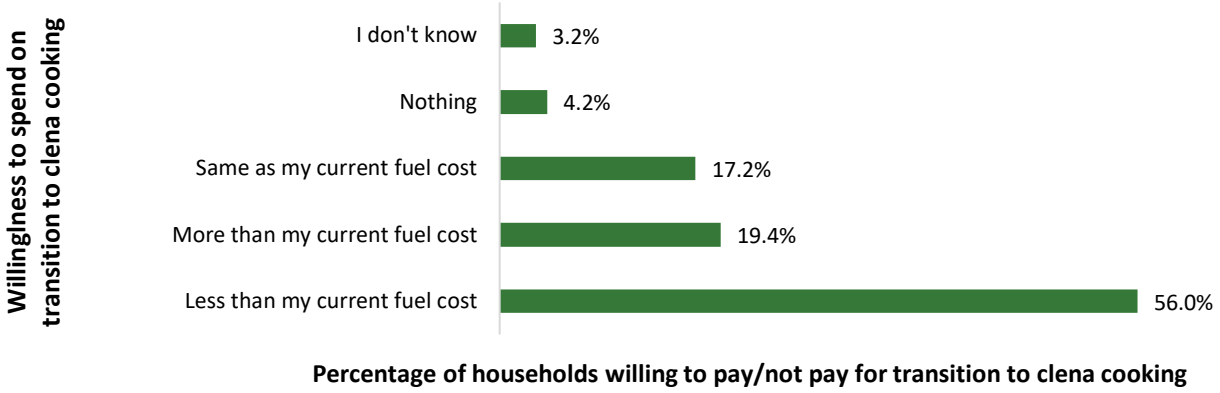
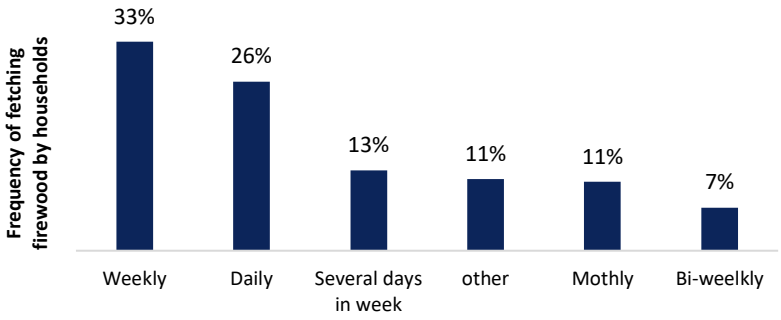


Figure 20: Willingness to spend on a transition to clean cooking

4.3.5 Comparison of various fuels used by households for cooking

Firewood

As discussed above, the use of firewood is highly prevalent across almost all households in the county. 53% of households fetch firewood to use for various purposes. As illustrated in **Figure 21**, the majority of households fetch firewood on a weekly basis (33%) while up to 26% of households fetch firewood on a daily basis. This means a lot of time that could be spent for other more productive activities is spent fetching wood each day. About 65% of households spend less than an hour each time when they go out to fetch firewood; there are also extreme cases where households spend 6 hours or more when fetching wood. 60.9% of female-headed households fetch firewood for cooking, while 52.9% of male-headed households fetch firewood for cooking. As per the interviews conducted, the dominant use of fuelwood is mainly because it is affordable, i.e., easily and freely collected, easily available and accessible from the nearby forests.



Amount of time spent fetching wood per household	Percentage
Less than 1 hour	65%
1–2 hours	26%
3–5 hours	6%
6 hours or more	4%

Figure 21: Frequency and time spent fetching firewood per household

Whilst most households fetch firewood, some households also buy firewood. 31% of households buy firewood and mostly do so on a weekly basis. Households buying firewood spend an average of KES 1,111.38 per month on this. Furthermore, 40.4% of female-headed households buy firewood for cooking, while 29.5% of male-headed households buy firewood for cooking in their households.

Table 13: Household monthly spending on firewood as a function of household head

Household head	Average amount spent on buying firewood per month (KES)
Child	437.5
Father	1,212.1
Mother	932.1
Other	2,500.0

In this assessment, 88.3% of the respondents indicated that LPG (Liquefied Petroleum Gas) is universally distributed/available in their area, even though only 53.3% of respondents use LPG in their households. LPG is predominantly used in the urban and peri-urban areas, while users in rural areas only do so occasionally as part of their secondary fuel use after biomass. The affordability of gas and gas stoves and to a lesser extent, their availability, are the major factors hindering the use of gas stoves in Nakuru County. There are also still a number of households who do not use gas because they do not like it (1.5%), while others do not know why they do not use it (0.5%), as shown in **Table 14**. This is a call to implement awareness-raising campaigns and innovative business models that will improve the affordability and availability of the gas stoves, gas cylinders and the gas itself. One reason related to the non-use of LPG in households is the potential danger of fire incidents in the household as mentioned by some respondents. Also, some households mentioned the convenient availability of firewood as a reason to not use LPG. Even though LPG is also available, the cost of purchasing and transporting the cylinder is relatively higher. The LPG cylinders are also not available in certain rural and remote parts of Nakuru, thus hindering access, as well as affordability.

Overall, while LPG provides an opportunity for clean cooking, several factors including cost, distribution, and cooking culture, hinder its adoption by certain households, especially in rural areas.

Table 14: Reason for non-use of LPG in households

Reason for not using gas in household	Percentage
It is too expensive	56.6%
Household can't afford gas appliances	28.6%
Other	6.6%
Gas is not available in my area	6.1%
Household does not like gas	1.5%
I don't know	0.5%

94.9% of those not using LPG in their households are willing to use it. Factors favouring the use of gas are ease of use (40.2%) and affordability (35.7%). 5.8% of the respondents prefer gas due to its safety. This means awareness-raising campaigns need to be put in place to communicate safety measures related to the use of gas. Besides the factors outlined in **Table 15**, most other respondents prefer it because it is very fast to use, easy to control and does not produce soot (soot is a deep black powdery or flaky substance consisting largely of amorphous carbon, produced by the incomplete burning of organic matter).

Table 15: Reason for preference for LPG

Why do you prefer to use gas?	Percentage
It is easy to use	40.2%
It is affordable/cheap	35.7%
other	10.3%
It is easily available	8.0%
It is safer	5.8%

As depicted in **Figure 22**, 50% of those using gas use it on a daily basis, while the rest use it occasionally (36.2%) and others, once in a while (13.8%). To assess the LPG supply to households in Nakuru County, the study explored how residents refill their LPG gas cylinders. The local shop vendors play a significant role, supplying 65.1% of residents with LPG, while others obtain gas from petrol stations (34%) and the rest from other sources (e.g. supermarkets). Furthermore, 79% of those using LPG buy it once a month, and the rest, when they can afford it (18.3%), daily (2.2%) or weekly (0.4 %).

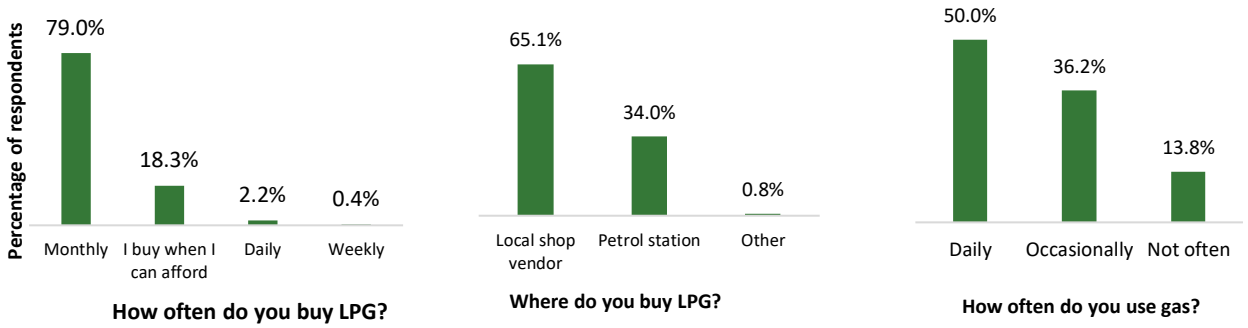


Figure 22: Frequency of use and purchase, and source of purchase of LPG

Most households (67%) using gas for cooking spend less than KES 1,000 on buying the gas and an average of KES 1,198 a month on LPG. This shows that strengthening the supply chain, especially retail suppliers, and diversifying payment options could enhance the adoption of LPG, especially among rural households.

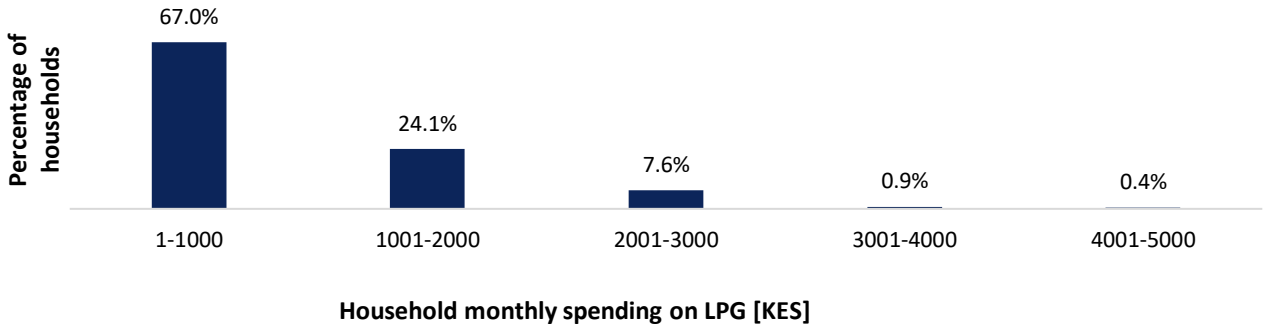


Figure 23: Household monthly spending on LPG

Paraffin

The use of paraffin seems to be less common in Nakuru County. Even though 81.2% of the residents acknowledged the availability of paraffin in their neighbourhoods, only 26.2% actually use it. The reason for the very low usage of paraffin is associated with a number of factors: households not having paraffin appliances (35%), it is thought to be dangerous (20.8%), the smell (14.2%), the high cost (9%), the unavailability in the area (4.3%), amongst other factors. Moreover, most of the residents (91.6%) are aware of the dangers and health risks of using paraffin in the household and are not willing to use paraffin in the future. Paraffin use is largely labelled as a secondary/alternative fuel, as many of those interviewed admitted to using it only when their charcoal is out of stock, during a blackout, and when the gas is depleted.

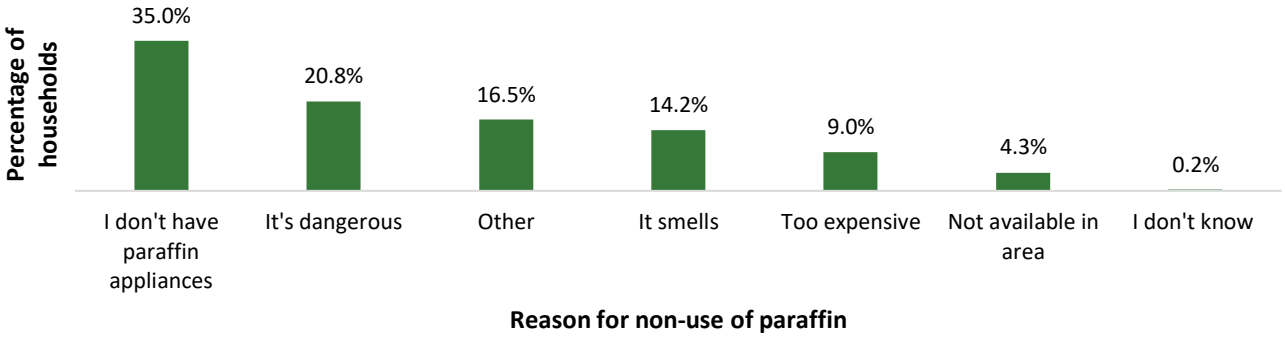
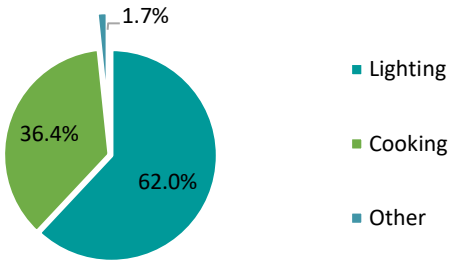


Figure 24: Reason for non-use of paraffin

The use of paraffin in the county is mostly for lighting (62% of households), while 36.4% use it for cooking and 1.7% use it for other purposes. Paraffin is largely used by households with access to electricity as a back-up during power outages, as well as for households with no access to electricity to light their homes at night.



An average of 45.04 L of paraffin is bought each time, with most respondents (40.8%) buying a litre each time (minminimum quantity bought), followed by those who buy in 5L each time (15%). The maximum amount bought each time is usually 800 L by only 0.9% of the respondents. Amongst other factors, the amount of paraffin bought is mostly determined by how much the household can afford (55.9%) and also by how much they need (36%) and the rest by the size of the container, amongst other factors. The frequency of buying paraffin varies significantly amongst households, with most (28%) buying it monthly, and 21.8% weekly, while a significant percentage buy it only when they can afford it (11.8%). The analysis shows other factors such as buying when out of gas, when there is a power outage, and even as frequently as every 2 to 3 days or every two weeks.

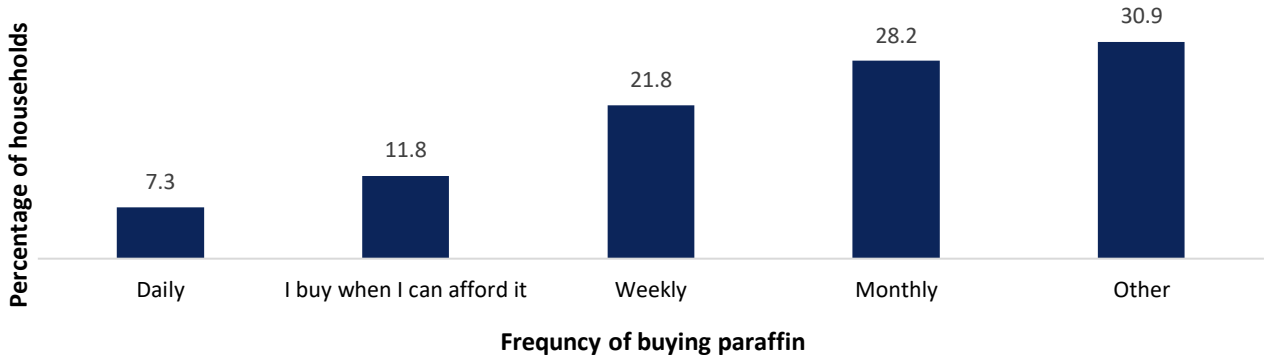


Figure 25: Household frequency of buying paraffin

The amount of money spent a month on paraffin varies from as low as KES 10 to as high as KES 9,000, with an average spending of KES 434 and with the majority of respondents spending KES 200 (18.8%) a month (see **Figure 26**).

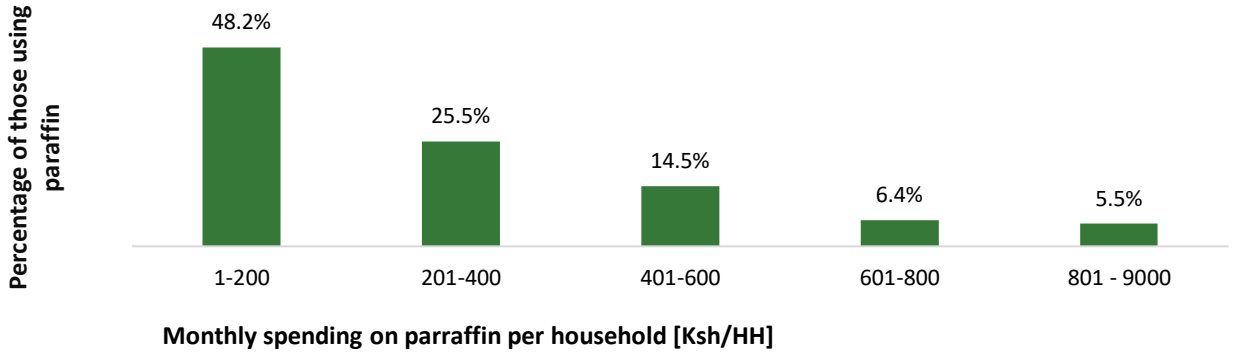


Figure 26: Amount spent by respondents on paraffin per month

4.4 Comparative analysis of energy types used in households

This section of the assessment includes a comparative analysis of the main energy types used by households in Nakuru County, namely electricity, LPG, paraffin and firewood. The objective of this is to assess reasons why households prefer different energy types, what they actually use the different fuels for, challenges encountered in using each fuel, as well as the monthly expenditure on each type.

4.4.1 Availability, usage and willingness to transition to a given energy type

In addition to firewood, other energy types such as paraffin, gas and electricity are generally available in the county as confirmed by the respondents during the survey. However, the uptake and usage of these energy types is significantly low, with just 63.8% using electricity, 52.2% using gas and 26.2% using paraffin. It is also important to note that households are willing to transition to cleaner energy types like electricity and gas, compared to paraffin where willingness to use is very low (8.4%). This means that most households in the county understand the health and environmental dangers of paraffin and are willing to transition to cleaner energy types.

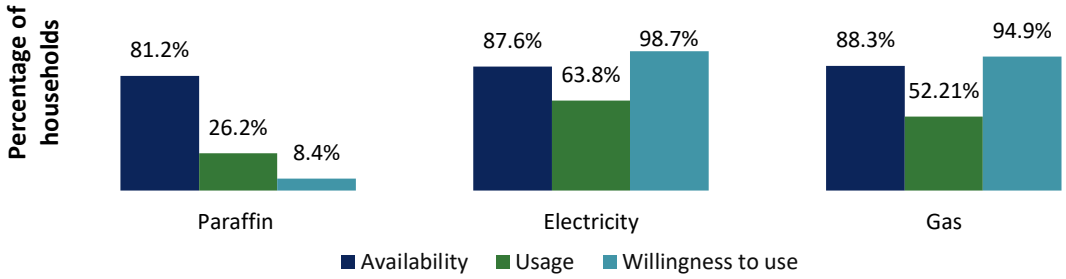


Figure 27: Availability, usage and willingness to transition to different fuel types

4.4.2 Reason for non-use of different energy types

The reason for the low usage rate of some energy types is associated with a number of reasons, particularly cost, as illustrated in **Figure 28**. The challenge of cost and affordability is mostly related to the use of LPG compared to the other fuels, probably associated with the up-front cost of the gas cylinders. The main reason hindering the use of electricity is that of unavailability of grid lines and transformers. Hence, solving the electricity access challenge will mean availing households of decentralised electricity access solutions like mini-grids and solar home systems. The percentage of respondents complaining about the affordability of electricity is relatively low (28.3%). This means that actions that focus on improving availability of electricity are much more needed. Finally, in terms of paraffin, the unavailability of appliances, perceived dangers and smells associated with its use are amongst the main reasons contributing to low usage rates in the county.

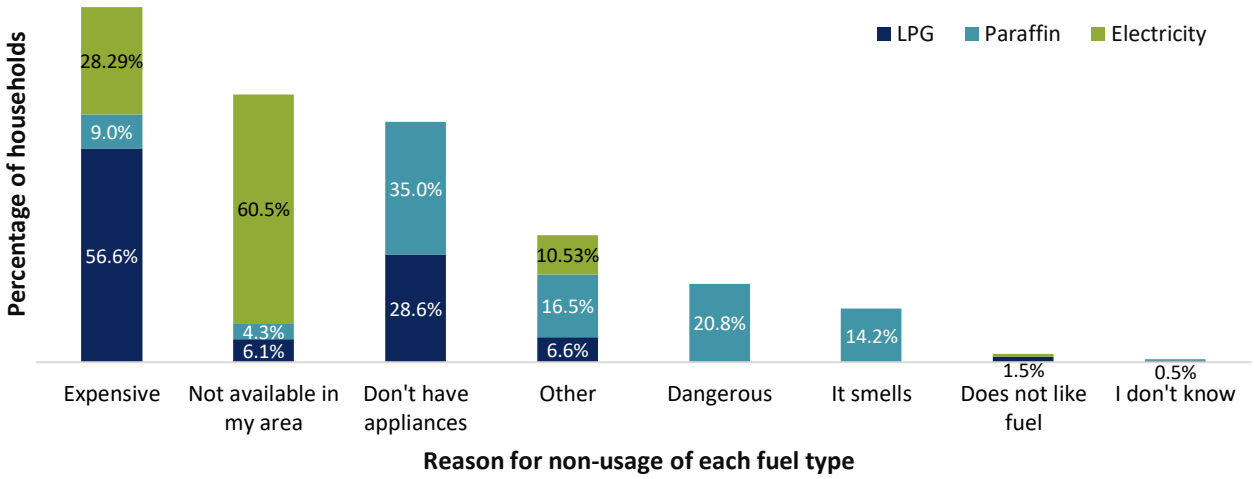


Figure 28: Reasons for non-use of different fuel types

4.4.3 Frequency of buying different energy types

The frequency of purchasing different energy types can be used to determine different interventions that can be explored to improve energy access in the county. For instance, most households using gas buy it monthly or when they can afford it. Putting this together with the affordability factors hindering uptake/usage of gas means that different business and distribution mechanisms which encourage distribution in smaller cylinders will motivate uptake. Also, different business models such as pay-as-you-go or concessional loans can be explored to relieve households of the high initial cost of gas cylinders.

Electricity is typically bought by households on a monthly basis (56.4% of households) and others when they can afford it (20.9%) or even on a weekly basis (17.2%). The purchasing frequency of electricity varies more because households are able to either use a pre-paid or post-paid method. The higher variability in the purchasing frequency of paraffin and firewood is due to the fact that these fuel types are often bought in very small quantities (daily and weekly purchases are very common). The frequency of buying firewood is also influenced by the fact that some households are able to fetch on a daily (26.3%) or even weekly (32.6%) basis more often than they buy. This shows that households are easily inclined to buy fuels that can be bought in smaller quantities, hence the prevalence of biomass in the county.

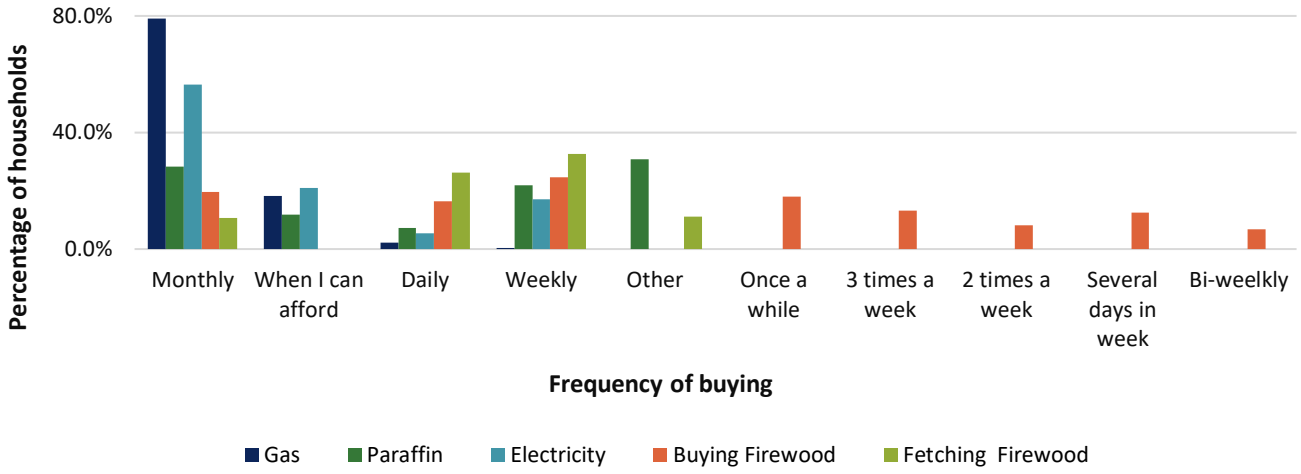


Figure 29: Frequency of buying of different fuel types

4.4.4 Expenditure on energy types

Since the frequency of purchasing different energy types varies significantly, it is only through assessing the average monthly spending on the energy types that a household can make an informed decision on which fuel type is actually cheaper. As illustrated in **Table 16**, a comparative analysis shows that on average, the least is spent on paraffin, with an average monthly expenditure of KES 458.8/month and the most is spent on electricity, with an average monthly expenditure of KES 1,450/household. Comparing the minimum amount spent a month, electricity is still the most costly, at KES 250, followed by gas at KES 142. It is recommended that more studies be carried out to analyse the reasons for spending such varying amounts on gas in the county, given that the price of an average gas cylinder in Kenya is KES 1,050 for a 6 kg gas cylinder refill (TotalEnergies, n.d.).

Table 16: Monthly spending on different fuel types

Monthly spending on fuel	Paraffin	Gas	Electricity	Firewood
Minimum	50	142	250	50
Maximum	4500	3500	8000	6000
Average	458.8	1191.37	1450	1111.38
Mode	200	1000	500	1000

The monthly spending on each fuel type is also influenced by the frequency of usage and on the various end uses of the fuel. Electricity, for instance, is used for a number of purposes (lighting, cooking, heating, cooling, etc.) and is also the most frequently (daily) used, for households using electricity. The household average monthly spending on paraffin is very low because it is often used as a secondary fuel for lighting and/or cooking, and when the household has ran out of firewood, to start a fire, or to light the house during a power outage. There is a remarkably high spending on firewood, compared to other fuel types such as electricity and gas. Most households (especially those buying firewood) are of the perception that firewood is cheaper to use, hence the dominant reliance on traditional biomass for cooking. This therefore means that there is a need for awareness-raising campaigns that will communicate the cost benefits, in addition to the environmental and health benefits of using cleaner energy types.

5. Conclusion and recommendations

The goal of this report was to provide an overview of the access to energy status of households in Nakuru County, with a special focus on access to electricity and access to clean cooking in households.

Overall, the assessment on access to electricity and usage shows that Nakuru County has great potential to achieve 100% electricity connection, due to its rich energy resource base. However, connection costs and reliability are key factors that cause inequalities in access and use of electricity, with most poor households unable to afford connections and sustained use. While lighting remains the dominant use, the potential to open up multiple usages, including clean cooking and other energy enterprises, could provide opportunities for clean energy transition and poverty alleviation in line with the SDGs. Pro-poor interventions need to be scaled-up to enhance access and use, especially for the poor, and to avoid widening inequalities in access and benefits. Summarised in **Table 17** and **Table 18** are the key indicators for access to electricity and access to clean cooking for households in Nakuru County, as guided by the requirements of the Joint Research Centre (JRC) requirements, and resulting from the data collection and analysis that was performed.

Table 17: Access to electricity indicators for Nakuru County

Attribute	JRC indicators	Value
Overall	Percentage of population or households having access to electricity (grid/off-grid) [%]	63.8%
Security (SC)		
SC2	Number of hours per day of available electricity [h/day]	20.24 hours/day
SC3	Average number of electricity interruptions per day [n°/day]	1.2 interruptions/day
SC4	Number of days without electricity per year [n°/year]	56.4 days/year
Sustainability (SU)		
SU5	Percentage of electricity from RES [%]	93%
SU6	Number of mini-grids and stand-alone systems [n°]	TBC
SU7	Laws and regulations in place for mini-grids/stands-alone systems?	Yes
Affordability (AF)		
AF8	Percentage of population willing or able to pay for electricity [%]	71.7%
AF9	Percentage of expenditure of public buildings on electricity [%]	TBC
AF10	Financial and regulatory incentives for renewable energy in place?	Yes

Table 18: Access to clean cooking indicators for Nakuru County

Attribute	JRC indicators	Value [units]
Overall	Percentage of population/households with clean cooking access	34.3%
Security (SC)		
SC2	Percentage of population/households relying on the traditional use of biomass for cooking	65.7%
SC3	Percentage of population/households relying on LPG or other sources	29.3% relying primarily on LPG
SC4	Availability of resources: time and distance to gather fuelwood [h and km]	Mostly less than an hour to fetch wood
Sustainability (SU)		
SU5	Number of improved cookstoves [n°]	40,164[4]
SU6	Sustainable production (charcoal, biomass…) [Y/N]	Yes
SU7	Knowledge of respondents about awareness and/or education programmes in place?	Yes
Affordability (AF)		
AF8	Financial and regulatory incentives or subsidy mechanisms in place?	Yes
AF9	Percentage of population willing or able to pay for the transition to clean cooking [%]	95.8% willing to pay for a transition[5]

Overall, the assessment shows that access to electricity and clean cooking is driven by many factors, including geography, urban versus rural systems, policies, and household characteristics such as income levels. While clean energy options are available in most parts of the county, many households especially in rural areas are unable to afford both the initial and operating costs. Even for those who have been able to connect to these options, the usage is relatively narrow, mainly focused on lighting for electricity, while LPG is largely used as a secondary source for cooking, after biomass. This means that the full potential for clean energy is not yet exploited. There is a need for a more catalytic strategy that will open up technologies and innovation for households and institutions to embrace full-range clean energy usage, including entrepreneurship for poverty alleviation.

The assessment has also revealed the inequalities in clean energy access, related to income inequalities, developmental and geographical differences. Access to electricity in Nakuru County is largely skewed towards urban and peri-urban areas enabled by infrastructure, affordability, and market demand. To address these inequalities, pro-poor and innovative strategies that explore a mix of grid and off-grid options could be useful.

Additionally, clean energy usage is constrained by reliability issues. Power outages, for instance, limit demand for electricity and associated uses, e.g., electric cooking. Consequently, electricity is mainly used for lighting while other options remain relatively dominant. This calls for innovations that catalyse technological access to various electricity sources and usages. Promoting diversity of uses is a particularly critical part of the clean energy transition. The assessment indicates that a clean energy transition is not only defined by access and connectivity but the ability to use clean energy. This presents a paradigm shift in global clean energy pursuit where the transition has largely been measured by access rather than sustained usage.

[4] ACTS team to confirm how these values were obtained.
[5] Though some households are willing to pay same amount (16.3%), less (53.2%), or even more (18.4%) to transition to clean cooking, other households are not willing to pay anything at all (3.96%).

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Annexures

Annex 1: Access to energy indicators

Access to energy indicators: Electricity

Attribute	Related Indicator
Overall	Percentage of population or households in having access to electricity (grid/off-grid) [%]
SC2	Number of hours per day of available electricity [h/day]
SC3	Average number of electricity interruptions per day [n°/day]
SC4	Number of days without electricity per year [n°/year]
SU5	Percentage of electricity from RES [%]
SU6	Number of minigrids and stand-alone systems [n°]
SU7	Laws and regulations in place for mini-grids/stands-alone systems [+/-]
AF8	Percentage of population able to pay for electricity [%] or willingness to pay
AF9	Percentage of expenditure of Public Buildings for electricity [%]
AF10	Financial and regulatory incentives for renewable energy in place [+/-]

Access to energy indicators: Electricity indicator codes

SC (2/3/4)	In many sub-Saharan African countries, electricity supply is unreliable. Frequently, supply is not sufficient to meet demand because of its instability, with a growth in the number of customers requiring electricity services. As a consequence, low electric power quality, exemplified by the occurrence of localised outages (interruption of the transmission and distribution of electricity due to a technical problem, a tampering or an overload) and loadshedding (load reduction as a controlled option to respond to unplanned events to protect the electricity power system from a total blackout), incurs significant costs (Ahlborg, et al., 2015) and badly characterises the quality of energy when it is available. The indicators in this category aim at assessing the reliability and the quality degree to which households and public buildings have access and use electricity. SC2 is the average number of hours of daily supply. SC3 assesses the average interruption of the energy supply during the day. SC4 is the shortfall in energy supplies during the year.
SU (5/6/7)	SU (5/6/7) – The share of renewable energy in the energy mix is crucial, also for creating more sustainable and inclusive communities. The solar energy potential for African cities is evident and it is gaining a wider consensus among citizens and stakeholders. SU5 – This indicator measures the share of renewable energy in electricity generation. The increase of renewable energy in the energy mix is an agreed target among international, national and regional levels. Renewable energy options are aggregated within the 80 calculation of this indicator. The share of renewables in electricity is calculated as the electricity generated by renewables divided by total electricity use.

SU (5/6/7)	SU6 – Technological innovations and new business models are making mini-grids a scalable option for expanding energy services in low-access areas like sub-Saharan Africa. Mini-grid solutions need to be tracked and monitored in order to get a better understanding of the current condition. SU7 – The regulatory uncertainty and inadequacy of policies may hinder the advancement of the off-grid sector. The development of a regulatory framework represents a key aspect to assess the current status and the potential development of a fruitful environment for the off-grid sector. The positive value of the indicator indicates that policies or regulations are in place or under development. On the contrary, a negative value shows a policy vacuum.
AF (8/9/10)	AF (8/9/10) – Affordable electricity in the sub-Saharan region is a multifaceted question. Affordable energy is a means to reduce poverty and increase the well-being of communities and is the basis for continuous progress. AF8 – The share of households able to pay and/or the amount households are willing to pay for electricity services represent figures that may guide stakeholders when making tariff decisions and policy makers when examining the welfare impacts and viability of these services (Abdullaha and Jeanty, 2009). Willingness to pay may be evaluated through surveys with different stakeholders as previously mentioned. Data regarding the percentage of households able to pay may be gathered by energy suppliers. AF9 – This indicator aims at assessing the incidence of electricity cost in public expenditure. The services provided by public facilities (health centres, schools, municipal offices, etc.) are determinant for the proper functioning of public affairs and for assuring wealth of communities. As a consequence, this indicator helps in determining if public facilities are able to afford these costs and may support policies towards cost reduction and energy efficiency, in order to keep the public services provided to citizens at an acceptable level. AF10 – Financial and regulatory incentives refer to measures to improve the financial returns or reduce the risk of private renewable generation projects. These mechanisms are one of the most cost-effective supports for private investments in this field. This indicator will be positive if there is at least one scheme to support renewable energy penetration or the provision of grants or subsidies. These may be framed at national level and then disseminated and further developed at local level, tailored to specific conditions in urban and rural areas

Access to energy indicators: Clean cooking:

Attribute	Related Indicator
Overall	Percentage of population/households with clean cooking access [%]
SC2	Percentage of population/households relying on the traditional use of biomass for cooking [%]
SC3	Percentage of population/households relying on LPG or other sources [%]
SC4	Availability of resources: time and distance to gather fuelwood [h and km]
SU5	Number of improved cook stoves used [n°]
SU6	Sustainable charcoal production [Y/N]
SU7	Awareness and/or Education programmes in place [Y/N]
AF8	Financial and regulatory incentives or subsidy mechanisms in place [Y/N]
AF9	Percentage of population able to pay (or willingness to pay) for the transition to clean cooking [%].

SC (2/3/4)	SC (2/3/4) According to OECD/IEA, 2017 access to clean cooking facilities means access to and primary use of modern fuels and technologies, including natural gas, liquefied petroleum gas (LPG), electricity and biogas, or improved biomass cookstoves, as opposed to the basic biomass cookstoves and three-stone fires. SC2 – The use of solid fuels, traditional biomass and coal, represent a measure of the deprivation of using more modern fuels. In the case data are not available, surveys may be conducted. SC3 – LPG is produced from natural gas liquids and from refinery supply and it is relatively safe compared to kerosene. LPG is transported and sold pressurised in cylinders, and therefore needs some distribution infrastructure, together with reliable roads. As a consequence, LPG is a common path to access clean cooking options, especially in urban areas (OECD/IEA, 2017). Along with LPG, other less polluting options are accepted. Data could be locally available. However, the indicator can be calculated by cross-referencing data from suppliers by local census. SC4 – Women spend numerous hours collecting fuelwood (usually at great distance from the household) and in cooking. It is crucial to develop more detailed figures on this aspect to build upon strategies to reduce time spent in those activities and, in parallel, improve the conditions of women.
SU (5/6/7)	SU (5/6/7) – The access to clean cooking is achievable principally through sustainable supply and improved cookstoves. SU5 – A traditional (or basic) cookstove is typically identified as a very cheap or no-cost device, characterised by very low efficiency and high burning of solid biomass. An improved biomass cookstove (ICS) typically describes a stove which has a higher efficiency or lower level of pollution than a traditional stove, through improvements. The introduction of improved cookstoves that decrease firewood and/or charcoal use contributes to the provision of clean cooking access in rural areas. SU6 – Sustainable charcoal production may reduce the impacts on the environment. There are already regulations and projects in place that support the use of certified charcoal. The indicator aims at assessing if there is sustainable production of charcoal within the boundary of local authorities and, if positive, to provide further information in this regard. SU7 – The increase of education and awareness about the importance of clean cooking and the fuel and time savings, health and environment co-benefits is necessary for the transition. As a result, this indicator assesses if programmes are already in place.
AF (8/9)	AF (8/9) – Affordability can be assessed through an overall perspective that includes issues related to sustainable and secure energy. AF8 – Financial and regulatory incentives and subsidy mechanisms refer to measures to boost the transition towards LPG or ICS. This indicator will be positive if there is at least one scheme to support the change in the supply or the provision of grants or subsidies. These may be framed at national level and then disseminated and further developed at local level. AF9 – The share of households able to pay and/or the amount households are willing to pay for changing the fuel and/or method to cook represent figures that may guide stakeholders when making tariff decisions and policy makers when examining the feasibility of financial policies. This indicator is strongly related to SU7 and AF8. Willingness to pay may be evaluated through surveys as previously mentioned. Data regarding the percentage of households able to pay may be gathered via energy suppliers.

Annex 2: Summary of consultative meetings held by the ACTS team

Consultative meeting	Date	Present	Key messages
Kick-off meeting	4th June 2020	ICLEI Africa, GIZ, ACTS teams	Introductions were made of the parties involved and their roles, the broader SEACAP process roadmap was explored including current status and timelines. Training needs of ACTS team was noted, deliverables and timelines discussed. Frequent meetings were set for every two weeks, MS Teams account was set up for easy file sharing and communications.
Follow-up meeting	15th June 202	ICLEI Africa, GIZ and ACTS team	N/A
Introduction to Nakuru County	17th June 2020	ICLEI Africa, GIZ, ACTS and Nakuru Team	N/A
Catch-up call	29th June 2020	ACTS, GIZ and ICLEI Africa	This included a follow up on the upcoming training on the SEACAP reporting template, inception plan, stakeholder engagement list, and training needs.
JRC training	10th July 2020	ICLEI Africa and ACTS	N/A
Follow-up meeting	15th July 2020	GIZ, ICLEI Africa and ACTS	This covered an inception report overview, stakeholder list, data sources and databases.
CoM SSA introductory training on energy modelling	15th July 2020	ICLEI Africa and ACTS	The training was an introduction to energy modelling using the LEAP model and CURB Tool in the SEACAP process.
Consultative follow-up meeting	27th July 2020	ICLEI Africa, ACTS and GIZ	At this meeting, the inception report comments, data collection rethinking and data sourcing logistics were discussed.

Annex 3: Questionnaire used for primary data collection

DEMOGRAPHIC INFORMATION	
1. Gender of the respondent	Male | Female | Prefer not to tell | Transgender.
2. Education level?	Pre-school | Primary | Secondary | Tertiary
3. Age of the respondent	18-24 years | 25-34 years | 35-44 years | 45-54 years | 55-64 years | <65 years
A. HOUSEHOLD INCOME	
4. Please select all relevant sources of income for your household	Formal Employment | Casual employment (Kibarua) | Own Business | Farming | Other
5. How much is your household income per month (KShs)?	Less than 5000 | 6000-15000 | 16000-25000 | 26000-35000 | 36000-45000 | 46000-55000 | 56000-65000 | 66000-75000 | 75000+
6. Who is the main earner in the household?	Father | Mother | Child | Grand-child | Non-relative | Other
B. COOKING OPTIONS	
7. What is the Primary cooking method used by the household?	Electric stove | Gas stove | Paraffin Stove | Energy Saving jiko (Jiko Okoa) | Jiko (Traditional jiko) | 3-stone fireside | Briquette | Biogas | Other
8. What is the secondary type cooking method do you use in the household?	Electric stove | Gas stove | Paraffin Stove | Energy Saving jiko | Jiko (Traditional jiko) | 3-stone fireside | Briquette | Biogas | Other
9. If you had a choice, what will be your preferred method of cooking?	Electric stove | Gas stove | Paraffin Stove | Energy Saving jiko (Jiko Okoa) | Jiko (Traditional jiko) | 3-stone fireside | Briquette | Biogas
10. Are you willing to transition to the use of cleaner cooking stoves for cooking?	Yes | No | I do not Know
11. Which clean cooking options are you willing to transition to?	Solar stoves | Biogas stoves | LPG stoves | Electric stoves | Other
12. How much are you willing to pay to transition to a cleaner means of cooking (operation costs)?	Nothing| Less than my current fuel cost | Same as my current fuel cost | More than my current fuel cost | Up to double my current fuel cost | I don't know
13. Does your household collect firewood for cooking (or making fire)	Yes | No
14. How often do you collect firewood?	Daily | Several days in week | Weekly | Bi-weekly | Monthly
15. Does your household buy firewood for cooking (or making fire)	Yes | No
16. How far do you travel to get your firewood (km)	
17. How much do you spend in buying firewood per month	
18. How long does it take you when you got out to fetch firewood	Less than 1 hour | 1-2 hours | 3-5 hours | 6 hours or more
19. How often do you buy firewood (wood to be used for cooking)	Daily | 2 times a week | 3 times a week | At least once every week | Once every month| Once a while | Never

DEMOGRAPHIC INFORMATION	
C. ACCESS TO ELECTRICITY	
20. Is electricity universally available in your area?	Yes | No | I don't know
21. Do you use electricity in your house?	Yes | No
22. Why you are not connected?	The connection is fee expensive | Gridlines are not available near to my area | The household does not like electricity
23. Are you willing to use electricity	Yes | No
24. Do you use electricity for cooking?	Yes | No
25. How often do you use electricity for cooking?	Daily | 3-4 times a week| Twice a week | once time a week Once time a month | Not often | I don't know
26. Why do you use electricity for cooking?	It is affordable/cheap | It is easily availablee | It is easy to use | It is safer
27. Do you use electricity for lighting?	Yes | No
28. How often do you use electricity for lighting?	Daily | 3–4 times a week | Twice a week | once time a month | Not often
29. Why do you use electricity for lighting?	It is affordable/cheap | It is easily availablee | It is easy to use | It is safer
30. Do you use electricity for heating?	Yes | No
31. How often do you use electricity for heating?	Daily | 3-4 times a week | Twice a week | once time a week once time a month | Not often
32. Why do you use electricity for heating?	It is affordable/cheap | It is easily available | It is easy to use | It is safer
33. Do you use electricity for cooling?	Yes | No
34. How often do you use electricity for cooling?	Daily | 3-4 times a week | Twice a week | once time a month | Not often | I don't know
35. Why do you use electricity for cooling?	It is affordable/cheap | It is easily available | It is easy to use | It is safer
36. Where do you get your electricity supply?	National utility grid | Own Renewable energy generation | Local mini-grid | Diesel generator | Gas generator
37. How is your household connected to electricity?	Own-meter | Shared meter | Extension cord from another source | Own system
38. How do you pay for electricity?	Pre-paid meter | Postpaid | I pay a private person | I get it free | I don't know
39. Have you ever stayed without electricity due to load shedding or technical faults from your electricity supplier?	Yes | No
40. What amount of electricity do you get in a month for free (amount in units or kWhs)?	
41. How often do you buy electricity?	Daily | Weekly | Monthly | I buy when I can afford it | I don't know

DEMOGRAPHIC INFORMATION	
C. ACCESS TO ELECTRICITY	
42. Is it the same amount every time?	Yes | No
43. Have you ever been without electricity because you did not buy enough?	Yes | No | I can't remember
44. What determines how much electricity you buy?	How much I can afford | How much I need | Other | I don't know
45. Has the electricity supply ever been suspended because the household did not pay the bill?	Yes | No | I don't know
46. On average, how much money do you spend on electricity in a month (amount in local currency)?	
D. USE OF GAS IN THE HOUSEHOLD	
47. Is gas (LPG) energy for cooking universally available in your area?	Yes | No
48. Do you use gas (LPG) in your household?	Yes | No
49. Which other type of gas do you use?	Biogas | Natural gas | other
50. Why don't you use gas?	The household does not like gas | It is too expensive | Household can't afford gas appliances | Gas is not available in my area | I don't know
51. Are you willing to use gas?	Yes | No
52. What do you use gas for?	Cooking| Lighting | Heating | Cooling | Other
53. Why do you prefer to use gas?	
54. How often do you use gas?	Occasionally | Not often | I don't know | Daily
55. Where do you usually buy your gas?	Petrol station | Local shop vendor | Other
56. How often do you buy gas?	Daily | Weekly | Monthly | I buy when I can afford
E. USE OF PARAFFIN IN THE HOUSEHOLD	
57. Is paraffin available in your area?	Yes | No | I don't know
58. Do you use paraffin in your household?	Yes | No
59. Why don't you use paraffin?	Too expensive | It smells | It's dangerous | I don't have paraffin appliances | it's not available in my area | I don't know what it is | Other
60. Are you willing to use paraffin in your household?	Yes | No | I don't know
61. What do you use paraffin for?	Cooking| Heating | Lighting
62. How much do you buy each time (Amount in liters)?	
63. What determines how much paraffin you buy?	How much I can afford | How much I need | Size of the container
64. How often do you buy paraffin?	Daily | Weekly | Monthly | I buy when I can afford it | Other
65. Have you ever been without paraffin because you did not buy enough?	Yes | No

DEMOGRAPHIC INFORMATION	
E. USE OF PARAFFIN IN THE HOUSEHOLD	
66. Besides money issues, have you ever not had paraffin in the household?	Yes | No
67. On average, how much money does the household spend a month on buying paraffin (Kshs)?	
F. Enabling Support	
68. What support do you receive from other agencies towards electricity/cooking energy access?	
69. What are the main challenges you face in accessing energy for lighting (electricity) and cooking?	
70. Which other source of energy do you use?	Solar Panel | Wind | Other

Annex 4: Types of cookstoves in Kenya

1. Three-stone stove (or three-stone fire): A traditional biomass stove with open fires and little to no ventilation. Fuel sources is predominantly firewood. (Stove emission level is assigned as Tier 0.)
2. Traditional charcoal stove: Mostly made from scrap metal. Open fire stove that uses charcoal as primary fuel source. (Stove emission level is assigned as Tier 0 or 1 based on features of the stove.)
3. Improved cookstove (ICS)—wood: May have a ceramic liner and improved insulation compared to the traditional stove. It uses less fuelwood than the traditional biomass stove, releases fewer fuel emissions compared to the traditional wood stove and has openings on the side to regulate air flow. (Stove emission level is assigned as Tier 1, 2, or 3 based on features of each stove type.)
4. ICS—charcoal: May have a ceramic liner and improved insulation compared to the traditional stove. Charcoal is the primary fuel for this stove. Compared to the traditional biomass stove that uses firewood, the ICS firewood stove is more efficient (due its insulation qualities) and uses less charcoal. It also emits fewer fuel emissions than the traditional charcoal stove. The rocket stove and multi-purpose stove are examples of the ICS charcoal stove. (Stove emission level is assigned as Tier 1, 2, or 3 based on features of each stove type.)
5. Kerosene stove: Two main types of kerosene stoves exist – the pressure and wick kerosene stove. Both use kerosene or paraffin as their main cooking fuel. Kerosene stoves are relatively inexpensive to produce, use the most affordable cooking fuel, and are easily accessible. The fuel is, however, highly flammable and polluting. (Stove emission level is assigned as Tier 2.)

Annex 5: Requirements for classifying urban and rural households in Kenya

As per the Urban Areas and Cities Act, 2011, an area may be classified as an urban area or city if it satisfies the criteria set out under this Act or any other written law. An urban area may be classified as a city under this Act if the urban area satisfies the following criteria— (a) has a population of at least five hundred thousand residents according to the final gazetted results of the last population census carried out by an institution authorised under any written law, preceding the application for grant of city status; (b) has an integrated urban area or city development plan in accordance with this Act; (c) has demonstrable capacity to generate sufficient revenue to sustain its operation; (d) has demonstrable good system and records of prudent management; (e) has the capacity to effectively and efficiently deliver essential services to its residents as provided in the First Schedule; (f) has institutionalised active participation by its residents in the management of its affairs; (g) has infrastructural facilities, including but not limited to roads, street lighting, markets and fire stations, and an adequate capacity for disaster management; and (h) has a capacity for functional and effective waste disposal.

A town is eligible for the conferment of municipal status under this Act if the town satisfies the following criteria— (a) has a population of at least two hundred and fifty thousand residents according to the final gazetted results of the last population census carried out by an institution authorised under any written law, preceding the grant; an area shall be eligible for the grant of the status of a town under this Act if it has— (a) a population of at least ten thousand residents according to the final gazetted results of the latest population census carried out by an institution authorised under any written law, preceding the grant.