

KITUI COUNTY ENERGY OUTLOOK



FINAL REPORT: DECEMBER 2017

Foreword

In meeting our county mission of providing effective services and an enabling environment for inclusive and sustainable socio-economic development and improved livelihoods for all, energy is set to play an important role in achieving our development ambitions. The County Government of Kitui has fully taken the mandate for planning and developing energy initiatives as stipulated in the 4th Schedule of the Constitution of Kenya 2010.

As a county government, we aim to provide affordable and sustainable energy alternatives to all households. It is our goal to provide an enabling environment for all residents so that everyone is accorded similar opportunities to economic growth and environmental sustainability.

Our energy plans are in line with the county's policies, Kenya Vision 2030 framework, Constitution of Kenya, the Energy Act 2006 and the proposed National Energy Policy 2015. Once implemented, the plans will go a long way in meeting the Sustainable Development Goals and contribute to the national agenda on Sustainable Energy for All.

This energy outlook report provides a snapshot of the current energy consumption in households and institutions within our county. It looks at our energy resources and their potential; initiatives we are undertaking to promote energy access and the processes of implementing and actualizing set policies and frameworks. It's only by understanding the energy sources, mix, preferences, factors influencing choice of fuels and technologies that we can better design projects and offer technologies that meets our people's needs at the least cost possible.

We aim to work with all stakeholders in order to promote equitable access to reliable and affordable energy within the county while promoting environmental sustainability and bettering the livelihood of its residents.

John Makau

County Executive Committee Member-Environment and Natural Resources

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The Directorate of Energy and Environment wishes to acknowledge the support of Worldwide Fund for Nature (WWF – Kenya) that made it possible for this report to be completed. Appreciation goes to Sustainable Energy Access Forum (SEAF- K) for selecting our county as a flagship project. The forum worked with the county officials to design and coordinate the entire study.

Appreciation goes to representatives of national government ministries and related institutions, especially the Ministry of Energy and Petroleum, Kenya Power, the Rural Electrification Authority, the Energy Regulatory Commission, the Kenya Electricity Transmission Company and the Kenya Forest Service for providing data and technical support.

The county government officials from planning, administration departments and other energy sector stakeholders who participated during the inception and technical review workshops will be remembered for their great input.

Finally, we are very grateful to the office of the governor for unwavering support.

Benjamin Musili

Director of Energy and Environment

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Acronyms

CBO - Community-based organization	kW - Kilowatt
CEEC - Centre for Energy Efficiency and Conservation	kWh - Kilowatt hour
CFAs - Community Forest Associations	LCPDP - Least Cost Power Development Plans
CPAs - Charcoal Producers Associations	LPG - Liquefied petroleum gas
CTAs - Charcoal Transporters Associations	MoEP - Ministry of Energy and Petroleum
EMC - Environmental management committee	MT- Metric ton
ERC - Energy Regulatory Commission	MW - Megawatt
FIT - Feed in Tariff	NDMA - National Drought Management Authority
GDC- Geothermal Development Company Limited	NEMA - National Environment Management Authority
GoK - Government of Kenya	NGO - Non-governmental organization
GWh - Gigawatt hour	NOCK - National Oil Corporation of Kenya Limited
Ha - Hectare	OIEPs -Oil Exploration and Production Companies
KAM - Kenya Association of Manufacturers	OMCs - Oil Marketing Companies
KEFRI - Kenya Forestry Research Institute	PIEA - Petroleum Institute of East Africa
KenGen - Kenya Electricity Generating Company	PV - Photovoltaic
KETRACO - Kenya Electricity Transmission Company	REA - Rural Electrification Authority
KFS - Kenya Forest Service	SDGs - Sustainable Development Goals
KMA - Kenya Maritime Authority	SE4ALL- Sustainable Energy for All
KNBS - Kenya National Bureau of Statistics	SEAF - Sustainable Energy Access Forum
KNEB - Kenya Nuclear Electricity Board	SEKU - South Eastern University College
KPC - Kenya Pipeline Company Limited	SLA - Service Level Agreement
KPRL - Kenya Petroleum Refineries Limited	SME - Small and medium-sized enterprises
KR - Kenya Railways Corporation	WRMA - Water Resources Management Authority
KRA- Kenya Revenue Authority	WWF- Worldwide Fund for Nature
KSh - Kenya Shilling	
kV - Kilovolt	

GLOSSARY OF TERMS

Energy access	The ability to avail energy that is adequate, available when needed, reliable, of good quality, convenient, affordable, legal, healthy and safe for all required energy services”. (Multi-Tier Framework-SE4ALL)
Cost(in Kshs)	Expenditure on/acquisition of energy (fuel/technology); cost of installation, Compensation: Payment in cash or in kind for an asset or a resource that is acquired or affected by a project at the time the asset needs to be replaced.
Solar Photovoltaic(PV)	*solar system above 50 Wp,
Solar home systems	*semi –Portable devices associated with small portable solar panel that power 1-3 LEDS bulbs, mobile phones, radios and other low power consuming accessories.
Solar lantern	*a portable device that offer directional lighting services
Bundle of firewood	*a portable device that offer directional lighting services
Sack of charcoal	*a portable device that offer directional lighting services
Quality	*Voltage problems that affect the use of desired appliances in electricity; for biomass - its characteristic by low calorific levels.
Accessibility	*ease of obtaining a product/service, consistently in a defined market place/institution.

EXECUTIVE SUMMARY

Background

Energy is a key driver to economic development, as the county government aims to provide effective services and an enabling environment for inclusive and sustainable socio-economic development and improved livelihoods for all, energy is set to play an important role in achieving these development ambitions. The 4th schedule of the Constitution of Kenya 2010, places the mandate for planning and minimizing the environmental impacts on activities for developing electricity and gas reticulation on county governments

The Ministry of Environment and Natural resources has an objective of improving energy access to majority of households through electrification and use of alternative energy solutions. In so doing, there is need to conduct research and provide timely information that can facilitate planning, implementation of activities and investments in the energy sector. Of importance is the need to link with processes like Sustainable Development

Methodology

The energy outlook development process was commissioned to assess and document the current energy situation within the county focusing on energy mix, cost of fuel and appliances, factors influencing fuels and technology choices. In collaboration with Sustainable Energy Access Forum - Kenya (SEAF-K), the Ministry of Environment and Natural Resources designed the data collection approaches. The research employed both qualitative and quantitative data collection methods including key informant interviews; stakeholder consultation; surveys and modelling. Cluster sampling was employed where a sampling frame was used to compute areas that were selected; this yielded 80 institutions and 394 households across the 5 sub-counties. Data was analyzed using R programme and Statistical Package for Social Scientist (SPSS).

Current status

To meet their energy needs, households utilize a range of energy sources and appliances for cooking, transport, power and lighting. Energy sources mix was characterized by firewood as the most used fuel by 73.9% of the households, kerosene by 47.7% followed by charcoal at 36.3%. Liquefied Petroleum Gas (LPG) usage was reported by 22.3%, while biogas and briquette stood at 0.5%. Crop residues are used by approximately 9.4% of the households. Use of solar energy devices was reported by 32% of the households while 23% of the studied households reported being connected to the national grid. There is also use of storage batteries for lighting and powering appliances.

The growth objectives as stipulated in the draft Kitui Vision for Economic and Social Transformation (KIVEST), Annual Development Plans and County Integrated Development Plan 2017 are set to increase energy demand. As the water provision sector continues to develop, demand for irrigation and pumping also increases, requiring more energy. Other sectors bound to increase energy demand include health and sanitation, education and agriculture sector particularly for food processing. As incomes increase and urbanization intensifies, household demand for energy will also rise. The electricity consumption in 2017 stood at 34.53GWh and by and the demand is projected to reach 50.97 GWh by 2026 under reference scenario and up to 75GWh under high reference scenario. Peak demand is also expected to increase from the current 4.9 GWh to about 12.26 GWh.

Solar, wind, biomass and coal form part of the energy resources with huge potential once fully exploited. The county has an annual average irradiation of 1400-1600 KWh/m²; this translates to a total of 45GWh of solar power potential per year. At 80 meters above ground level several regions experience 3-6 meters per second (m/s) of wind especially Mwingi plateau. Small wind farms can be considered for this wind speeds as well as mechanical wind pumping solutions.

Biomass utilized in form of firewood and charcoal, if sustainably harvested can sustain the current demand. However deficit can be experienced due to unsustainable harvesting and exports to other counties. The supply potential for Kitui County is estimated at 266,777m³ for firewood and 143,426 m³ for charcoal while the demand stands at 490,557 m³ and 428,212 m³ for firewood and charcoal respectively. This leaves a negative net balance of 508,342 m³. Feasibility studies by the Ministry of Energy and Petroleum estimates the coal reserves in Kitui County at 400 million metric tonnes. If fully exploited, the deposits have potential for electricity generation or being used in industries for heating.

To meet the growing energy demand, doubling investments in the sector through private public partnerships will be required. Financing of energy initiatives through public and private investment can accelerate programs and plans delivery. There is need to explore innovative financing mechanisms for public projects and at a household level including climate finance mechanisms. Productive use of energy at the household level and for small and micro enterprises needs to be promoted. Further, capacity building and training on energy conservations and efficiency at institutional and household level will go a long way in contributing to energy conservation. To plug the demand for energy and to attract more investments in the energy sector, the County will need to invest in research and feasibility studies. Additionally, adoption of cleaner fuels and efficient technologies, including good quality renewable energy products like solar, at the household and institutional level, will not only accelerate the embracing of alternative clean sources of energy, but also contribute to improved indoor air quality.

Good quality renewable energy products like solar have the potential to accelerate adoption through raising user's confidence.

Outline

Section 1 of this report gives a background to the socio-economic aspects of the county, and the study approach and methodology. Section 2 explores the different energy sources and consumption levels in households and institutions. It further examines factors influencing fuel and technology choices and willingness to pay. Chapter 3 provides an overview of different energy resources and their current potential while chapter 4 discusses some of the initiatives within the county as well as available infrastructure for promoting increased energy access. The report also outlines the legislative framework in the energy sector in addition to key areas and implications on energy demand and future projections.

1.0

INTRODUCTION

1.1 Background

Geographic Location: Located about 160km East of Nairobi City, Kitui County is the sixth largest county in Kenya, covering an area of 30,496.51 km². It is located between latitudes 0°10' and 3°0' South and longitudes 37°50' and 39°0' East. The county shares its borders with seven other counties namely: Machakos and Makueni counties to the West, Tana River County to the East and South-East, Taita Taveta County to the South, Embu to the North-West, and Tharaka-Nithi and Meru counties to the North.

Administrative structure: The County has eight (8) sub-counties namely; Kitui Central, Kitui West, Kitui East, Kitui South, Kitui Rural, Mwingi North, Mwingi Central and Mwingi West. It's further sub-divided into forty wards. The county is also set to be classified into proposed economic zones as shown in figure 1 to help in maximizing the potential for each area.

Demography and economy: The total population is estimated at 1,012,709 (48% male and 52% female), with a projected growth rate of 2.1%. The average population density was estimated to be 42 people per Km² and with a total of 205,491 households in 2013. The 2017 estimates put the population density at 46 persons per Km² with a total population of 1,108,518. Kitui and Mwingi are the major urban centers but there are upcoming ones like Mutomo, Kwa Vonza, Migwani, Tseikuru, Kabati, Tulia, Katse, Ikutha, Mutitu/ Ndooa, Zombe, Kyusyuni, Kyuso and Nguni.

Physical and Topographic Features: The county is characterized by arid and semi-arid climate, the low lying topography has an altitude range of 400m and 1800m above sea level. Rainfall distribution is erratic and unreliable ranging from 500mm to 1050mm per annum. The maximum mean annual temperature ranges between 26°C and 34°C; whereas the minimum mean annual temperature ranges between 14°C and 22°C. The rainfall pattern is bi-modal with two rainy seasons annually. The long rains fall in the months of March to May.

Economic activities: The main economic activities include agriculture comprising of food, cash crops and livestock; tourism; trade and industries like cotton ginnery, fruit processing plants and maize milling. The county has deposits of minerals such as coal, limestone, granite, gypsum, vermiculite, sand and gemstones. For instance Mui and Kyuso are rich in limestone and there are future plans for extraction. Gypsum is present in Mwingi South and gemstone at Tharaka and Tseikuru. Sand harvesting and mining of gemstones is done primarily by the local artisans.

Proposed Administrative and economic zones

The County has been divided into six economic zones based on various economic potentials and resource availability. The six economic zones include:

- Mui Coal Basin, whose main potential is the coal mining and livestock farming.
- Ikutha – Mutomo – Kanziko, whose main potential is mining of limestone, iron ore and other precious stones.
- Kitui Town and its environs, whose main potential is as a commercial and financial hub for the surrounding zones.
- Kwa Vonza – Kanyoonyoo belt, with the main potential of commerce, education and research & development.
- Mwingi town and its environs, whose potential is mainly considered as a commercial and financial centre. It has potential for tourism development.
- Kyuso– Muumoni- Tseikuru zone which has potential in irrigated farming and mining of limestone and other precious stones.

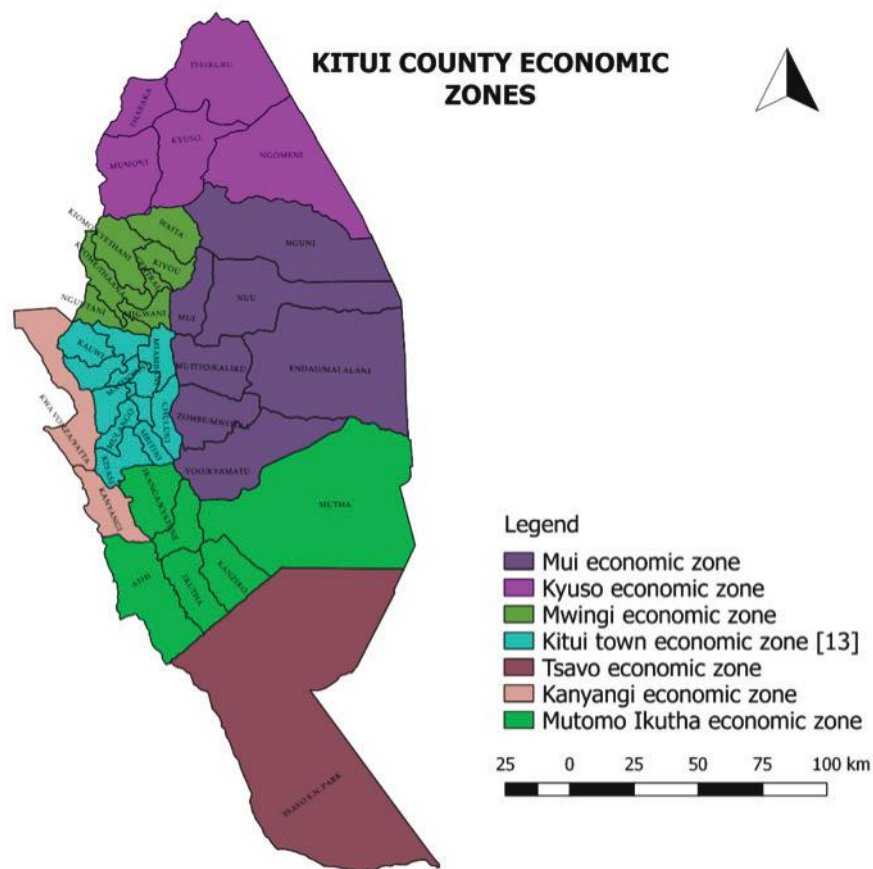


Figure 1 Proposed Economic zones

1.2 Scope and Approach

The Energy Bill 2015 stipulates in Section 5-6 that the Cabinet Secretary of the Ministry of Energy and Petroleum shall develop, publish and review strategy plans with respect to midstream and downstream petroleum, coal, renewable energy and electricity distribution to ensure delivery of reliable energy services at least cost. The Bill further states that each County Government shall develop and submit an energy plan to the national government.

Kitui County government, Worldwide Fund for Nature (WWF) and Sustainable Energy Access Forum (SEAF-K) established a partnership to assess and document the current energy status (supply and demand) in Kitui County with a view of creating baseline information upon which progress in energy access can be measured. Data on consumption, demand, energy sources preferences and financing mechanisms at household and institutional level, will assist the county and stakeholders in future design of programmes and investment plans focusing on provision of energy related products and services or other auxiliary services. The Ministry of Energy, Environment and Natural Resources will enhance future policy development and implementation. The information is anticipated to enable the county link with other ongoing national and international energy initiatives such as the Sustainable Energy for All (SE4ALL) and Sustainable Development Goals.

1.2

The process of developing this energy outlook entailed use of qualitative and quantitative research methods for data collection. Data was obtained through consultation with county

energy officers and stakeholders drawn from energy and other sectors. Literature review was undertaken in key energy planning documents like Least Cost Power Development Plan (LCPDP); Rural Electrification Master Plan; Kitui County Integrated Development Plan (2013-2017); Draft Kitui Vision for Economic and Social Transformation (2015); sector plans and reports. Information was also sourced from national agencies like Ministry of Energy and Petroleum; Rural Electrification Authority; Kenya Power among others. The study also benefited from primary data that was gathered from sampled population of households and institutions. The sampling framework used sub-county as clusters where enumeration areas were selected. The survey reached out to 80 institutions and 394 households with an average household size of 5 members. Table 1 shows the respondents from respective wards.

Table 1 Survey respondents

Sub county	Ward	No of Households	%
Kitui West	Matinyani	93	23.6
Kitui South	Mutha	46	11.7
Kitui South	Ikutha	31	7.9
Kitui Rural	Kwavyonza/Yatta	56	14.2
Mwingi North	Kyuso	57	14.5
Mwingi Central	Waita	61	15.5
Mwingi Central	Nuu	50	12.7
	Total	394	100

The study engaged a total of 394 households comprising of 45.2% male respondents and 54.8% female. The highest percentage type of household is male headed with a spouse at 61.8%, followed by female headed at 18.6% and 10.3% male headed: single, divorced or widowed. Primary source of income is gained through formal employment by 27.8% of the surveyed households, 26.4% worked as casual laborers and self-employment while farming and other businesses stood at 23% and 22.8% respectively. Economic activities for households indicate majority is from agriculture sector (21.6%) followed by trade and construction as shown in figure 2.

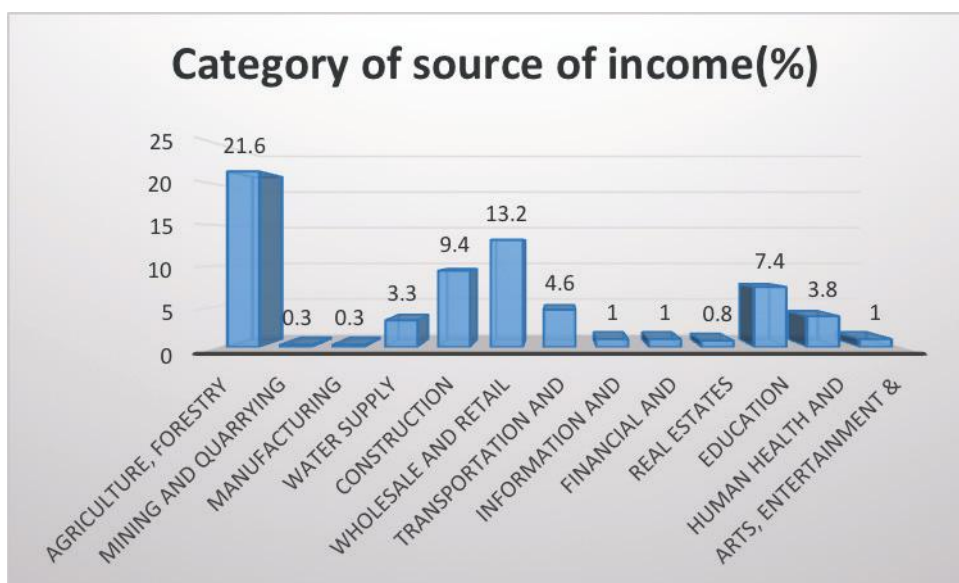


Figure 2 Household Economic activities category

Findings from table 2 indicate that 41.1% of the respondents obtain their incomes daily followed by the ones who get their incomes monthly at 32.3%. Households that are paid for the unit of work done stood at 21.6% and the least are those who get their income weekly 5.1%. When paying for energy services or products, it's important to understand the patterns of incomes and design innovative consumer financing options.

Table 2 Schedule of obtaining income

Payment schedules	Frequency	Percent
Daily	154	41.1
Weekly	19	5.1
Monthly	121	32.3
Pay for unit (piece of work)	81	21.6
Total	375	100.0

On average most households get an income ranging from Ksh 20,000 to Kshs 45,000 per month for the lower quantile and Kshs 60,000 and above for the upper quantile. Although income levels can indicate the socio- economic status and hence ability to pay for energy services or products, record keeping on income is always tricky and prone to over or under reporting.

Income Distribution

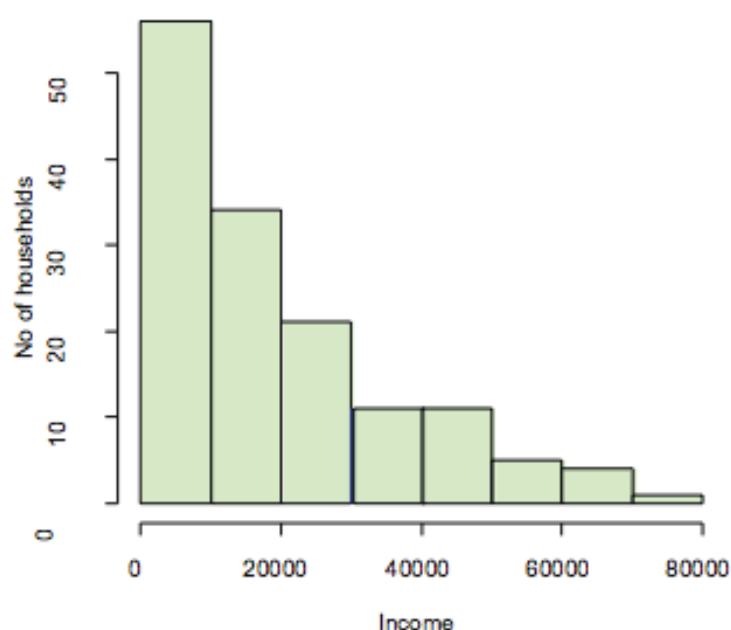


Figure 3 Household income levels

2.0

ENERGY MIX AND CONSUMPTION

Households

To meet their energy needs, households utilize a range of energy sources and appliances for cooking, transport, power and lighting as depicted in figure 4. For cooking purposes, households use a mix of fuels either as primary or secondary source which includes firewood, electricity, kerosene, charcoal, LPG, crop residual, briquette and biogas. Firewood is the most used fuel by 73.9% of the households. The second most used fuel is kerosene at 47.7% followed by charcoal at 36.3%. Liquefied Petroleum Gas (LPG) stood at 22.3% while briquette and biogas were reported by 0.5% of the households. Use of crop residues was reported by 9.4% of the sampled households. For lighting purposes, 23% of the population use electricity, 38% kerosene, 7.8%, storage batteries and 32% use solar energy. There is also minimal use of candles especially for back up.

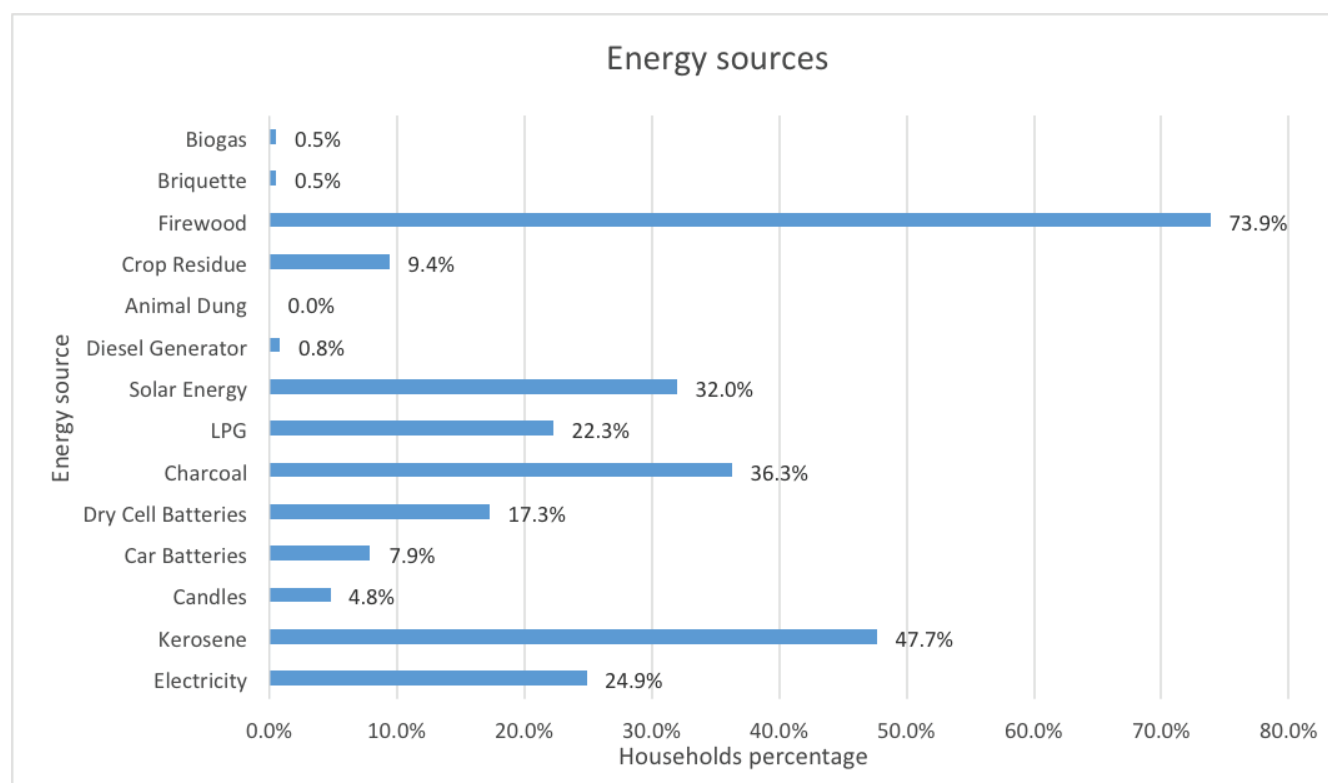


Figure 4 Energy sources

2.1. Electricity

The study finding showed that 24.9 % of the households are connected to the national grid, with electricity mainly being used for lighting and appliances. Only 8% of the connected households use electricity for cooking. Majority of the household bulbs rating was 40 watts with some as high as 100 watts, indicating the need for promoting energy efficient lighting. Common appliances include radio, television and phones which generally consume low power due to their low rating. High power rating appliances included refrigerator, iron box and water heaters. From the appliance listing, electricity for productive use or business was not noted in the households. In meeting their power needs, households on average use electricity for 3 hours per day apart from appliances like radio which is used even for 8 hours or more.

Cost: The monthly bill range from Kshs 500 to Kshs 3500, the analysis excludes the households that paid their bills together with the rent. There has been an apparent notable change in the cost of using electricity as reported by 42% of users. This was mainly attributed to the increase in fixed charges. Maintenance costs that are experienced include replacing of bulbs and sockets, as well as wiring and parts replacement. The study couldn't ascertain if this is attributed to the quality of the products, power outages or the fluctuations associated with grid electricity. Approximately 52 % of the households felt that the use of tokens is cheaper. With new distribution lines under construction in areas like Matinyani and Kwa Vonza, the households felt that electricity will be more accessible despite the high connection fee.

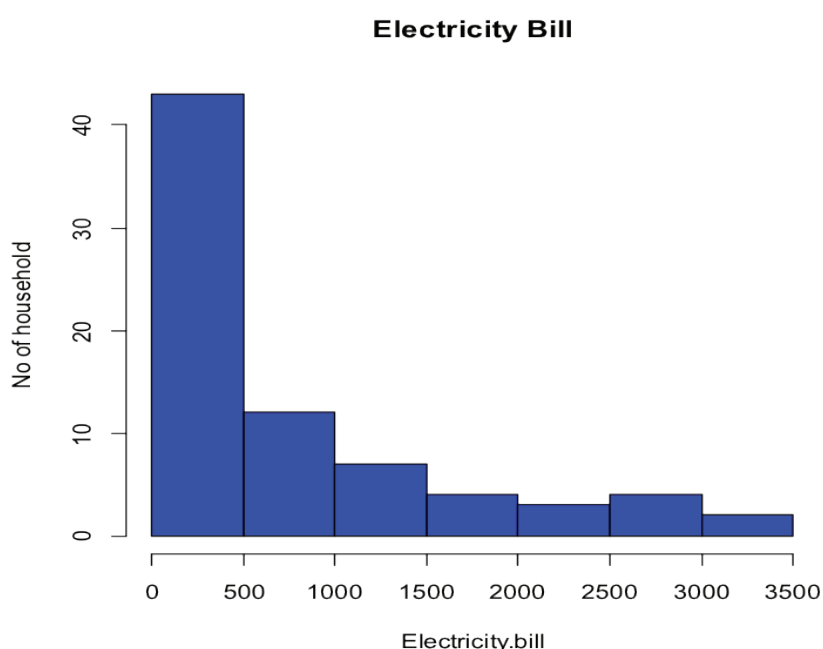


Figure 5 Household monthly bill (Ksh)

2.2 Kerosene

The study finding showed that 24.9 % of the households are connected to the national grid, with electricity mainly being used for lighting and appliances. Only 8% of the connected households use electricity for cooking. Majority of the household bulbs rating was 40 watts with some as high as 100 watts, indicating the need for promoting energy efficient lighting. Common appliances include radio, television and phones which generally consume low power due to their low rating. High power rating appliances included refrigerator, iron box and water heaters. From the appliance listing, electricity for productive use or business was not noted in the households. In meeting their power needs, households on average use electricity for 3 hours per day apart from appliances like radio which is used even for 8 hours or more.

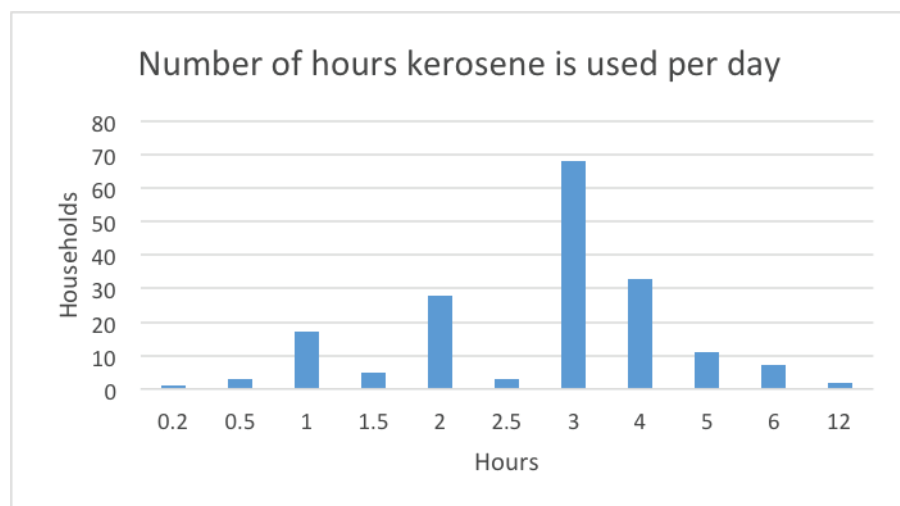


Figure 7 Quantity of kerosene consumed per month

2.3 Liquefied Petroleum Gas

The number of households with liquefied petroleum gas (LPG) stood at 22.3% most of them using 6KG and 13Kg cylinders. Refilling 6kgs costs about Ksh 900 and is used for 2 months while 13kgs would last roughly for 2- 3 months and the refilling cost range between Kshs 2100 and Kshs 2800. Households recorded an average cooking time of about 1- 2, 5 hours per day. Where LPG is used as a secondary source of cooking, it is mostly used to cook light meals.

LPG is preferred because it's fast and requires small storage space and it's environmentally friendly. Some drawbacks includes high cost of refilling and in some areas the distances to nearest market/ dealer is prohibitive. Households felt that accessibility has improved overtime with more dealers and petrol stations coming up and some dealers are establishing free delivery but up to a certain radius in kilometers. There are no notable changes in quality and prices have remained constant according to 22% of the sampled LPG users.

2.4 Solar

Solar energy constitutes the 4th most commonly used energy source at 32 %. Solar devices mainly used in the county are Solar PV systems at 36.3%, pico solar home system at 30.6% and solar lantern at 33.1% as shown in figure 8. The solar system comes in different sizes ranging from 40 to 200 watts. Most of the households who use solar find it cheaper and reliable especially if proper sizing is done, however, the cost of the installation is high, and there is lack of information on the concept of solar especially with regard to installation as well as maintenance.

Some challenges cited by the households include inadequate knowledge of solar systems hence difficulty in decision-making. Also noted was the lack of knowhow in operation and maintenance and the high cost of acquisition if required to pay the whole amount upfront. On accessibility, households noted that the devices are easy to find in the market in addition to the fact that suppliers can bring them to the homestead. On financing, institutions are setting up financing mechanisms such as creating loan products. Common interest groups are also coming together to purchase solar products.

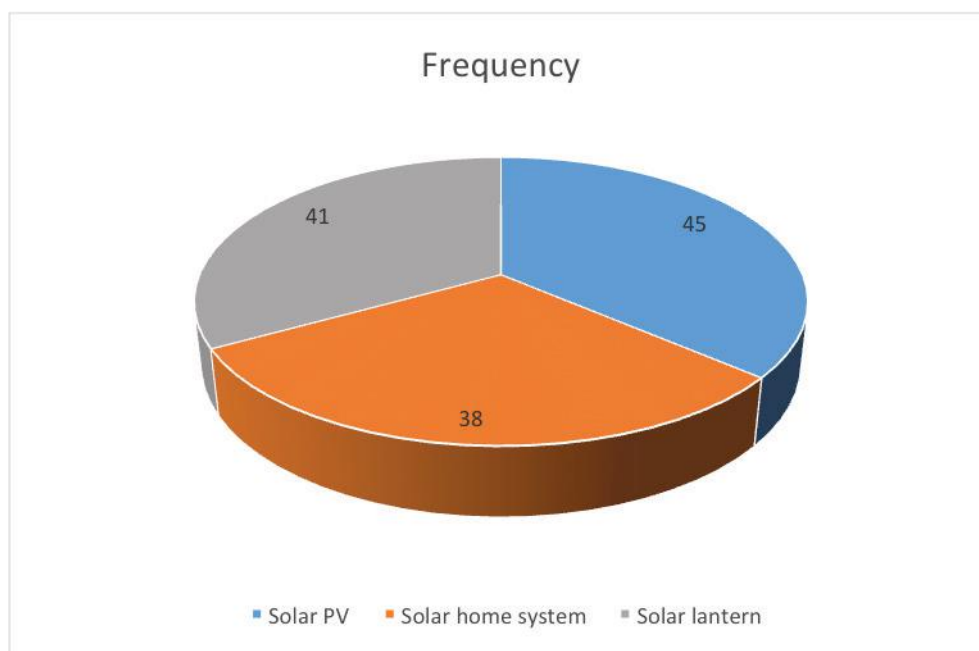


Figure 8 Percentage of solar devices used in Kitui County

2.5 Storage and dry cell batteries

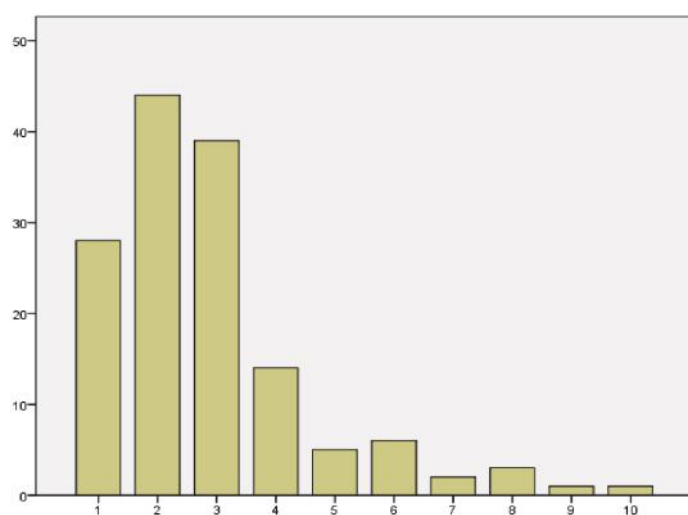
8% of the households use storage batteries mainly for lighting and powering appliances. Depending on quality, the purchase price ranges between Ksh 6000 and Kshs 15,000. Once fully charged, a car battery can last a household for 2 to 4 weeks with majority of households using between 1 and 3 hours per day. Advantages include its multipurpose use for lighting and other appliances and it's rechargeable. Storage batteries initial cost is noted to be high and it's hard to tell a good quality battery. There is also limit to the number of appliances that can be powered by the battery. Most of the storage battery selling points are far in the major towns and therefore access is limited to a number of the rural residents.

The use of dry cell batteries is mainly for radio and powering flash lights (torches). Prices of dry cell batteries remained constant but 61% of users noted that the quality has decreased due to the entrance of several manufacturers that produce short lasting batteries. Since the demand has been declining, very few shops are stocking the product. Households have high preference for rechargeable flashlights, which are available in the markets.

2.6 Charcoal

Charcoal is the preferred source of energy for cooking by 36.3% of the households. Key advantages noted by households include its portability making it easier to transport from production sites to consumers, employment creation, cooking for long hours, its multipurpose uses including ironing and it can be purchased in small quantities. Households use charcoal for cooking for approximately 2 to 3 hours per day as shown in figure 9. Figure 10 depicts the quantities consumed per month ranging between 10 to 35 kgs. The average price per kilogramme of charcoal is estimated to be between Ksh 20 to Kshs 30. In the rural areas households produce charcoal as a source of income and some for own consumption. Analysis of consumption between households who produce their own charcoal – (20%) and those who purchase indicated that the former consume slightly less as shown in figure 11. This trend can be attributed to the fact that, rural households could be producing charcoal mainly for sale and there is high usage of firewood in the rural areas as compared to charcoal.

64.6% of those who use charcoal have an improved jiko. Improved jikos are acquired at a price ranging from Kshs 2000 to 3500 Kshs while the cost of metal jiko (with no ceramic lining) is obtained at a range of Kshs 150 to Kshs 800 depending on the size.



Hours per day vs number of household

Figure 9 Number of hours households use charcoal

There are notable changes in the cost of charcoal attributed to reduction of trees and high transportation cost to urban areas. Prices are even higher during the rainy seasons. There are additional costs which households feel are incurred by suppliers when they obtain permits from the county government. Quality change in charcoal is attributed to lack of good trees which force the charcoal producers to use immature and softwood trees.

Table 3 Charcoal accessibility

Accessibility	Percent
It is more accessible	27.3
Accessibility has remained constant	25.9
It has become less accessible	46.9

As shown in table 3, 46.7% of the households felt that the commodity has become less accessible as a result of the decrease in supply while demand continues to grow, tree density has gone down and production is taking place far from settlement areas raising transportation cost especially during the rainy season.

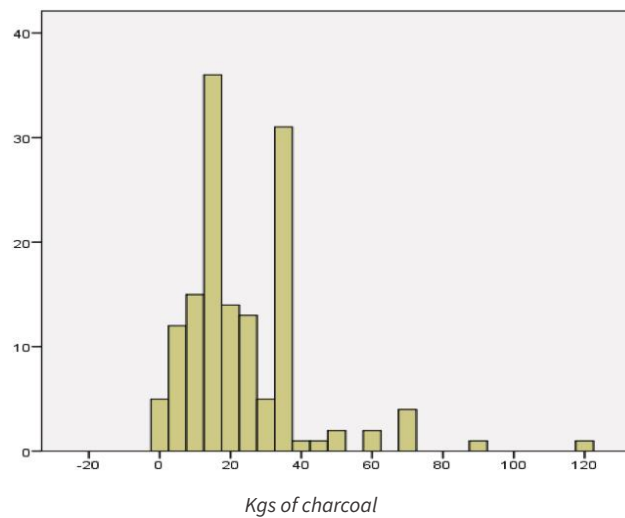


Figure 10 Charcoal consumption



2.7 Firewood

Firewood is the most widely used form of energy for cooking by 73% of the population surveyed. The firewood is mainly used on traditional three stone stoves and/or other forms of improved jikos like rocket stove.



Figure 12 Three- stone traditional wood stove and a rocket stove

Firewood has remained accessible over time though quality isn't consistent especially for households that purchase it from nearby markets in various localities. Collection of firewood from farms or forest would be done even up to 8 times depending on the household size and frequency of cooking. Firewood is preferred for cooking fast and it's also ideal for large meal cooking. It's cheaper compared to other energy sources though the price per bundle especially for good quality firewood is relatively high. This is associated with increase in deforestation, high population, demand from hotels and butcheries and cost of transport. Depending on the location, price per bundle ranges from Kshs 200 to 500 and can last from 2 weeks to one month.

2.8 Willingness to relocate

With only 0.5 % of the sampled households using biogas for cooking, there is potential for biogas growth. Limited skilled labour and high installation cost were noted as some of the challenges.

Some of the biogas digester models in Kitui County include fixed dome, floating drum and tubular model. Through the Micro Enterprises Support Programme Trust (MESPT) program whose objective was to promote biogas, 22 fixed dome digesters with sizes ranging from 6m³ to 24m³ were built by 32 trained artisans in Kitui County. Sasol Foundation built the oldest model in Mulango area in 2006; The Kitui Energy Centre has constructed a demonstration biogas unit and also offers training on the same. A 36 m³ Kitui Prison uses human waste and cow dung as the raw materials. The 36m³ floating drum model in figure 13 is using pigs and poultry waste as raw material. Tubular biogas units are also gaining popularity due to their low cost and a smaller space needed for installation.



Figure 13 A floating drum bio-digester in Matinyani Kitui County. Right: A fixed-dome model

2.9 Briquette and crop residues

Briquette: The County has minimal adoption of briquette. Only 0.5 % of the sampled households were consuming briquettes about 4 to 10 kgs per month. The advantages of briquette are that if made at home, there is minimal cost, they burn for a long time and raw materials are available. However it takes time to prepare requires space for drying and prior training on mixing the raw materials.

Biomass briquettes are a form of solid fuel that can be combusted to produce energy. They are produced by compacting loose biomass residues into solid blocks, they can take the different shapes like cylindrical or rectangular depending with the machine and the sizes also vary. They are ideal for domestic and institutional cooking and industrial heating processes. Briquettes can be made from biomass residuals such as charcoal dust (which is waste from the production process), coffee husks, coconut husks, maize cobs and sawdust amongst others.

Crop residues are used by 9.1 % of the population who utilize traditional three stones. On average, crop residue is used for 2-3 hours a day, and about 40kgs a month. It is collected once per week by majority of the surveyed households. With low farm yields, the crop residues have

reduced and it's also a fodder crop livestock. The residues are also smoky, have a lot of ash and are scarce making them unreliable.



Figure 14 Briquettes

Factors influencing energy type selection

Choosing a source of energy at household or institutional level is influenced by a number of factors. Modern energy technologies and fuels are anticipated to play a huge role in community shifting to more efficient and cleaner solutions. By creating awareness of different energy solutions, households stand a better chance of making informed decisions on which energy products or services to acquire.

From the survey, technology and fuel price/cost was recorded as the most important factor by majority of households as shown in figure 15. Cost of acquiring an energy source would vary from high capital cost with low maintenance to low capital cost with high maintenance/running cost.

Convenience of use was the second factor recorded as shown in figure 16. Energy products and services should be easy to use and suitable. This can be enhanced through offering basic technical skills training about the fuel or technology. Design of technologies like improved cook stove would then be considered appropriate with social aspects like staple food, frequency of cooking and other needs like heating.

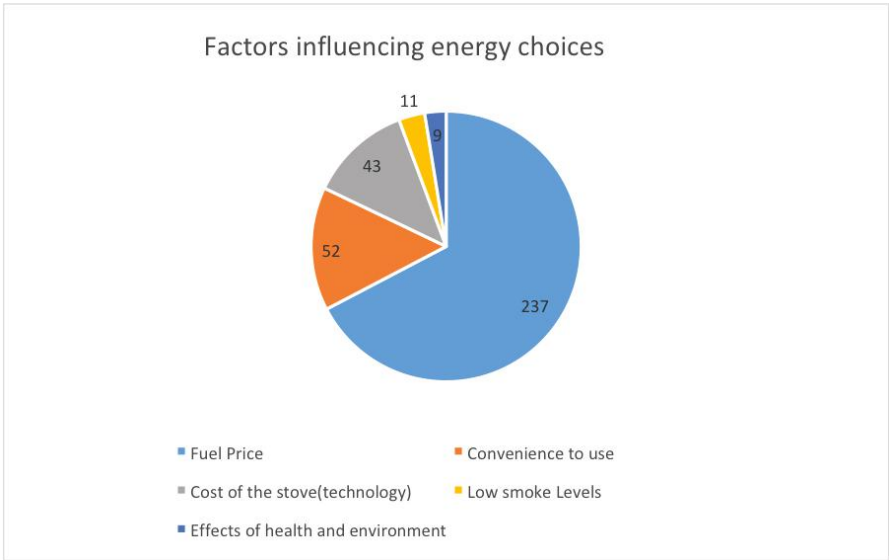


Figure 15 Fuel and technology price as a factor

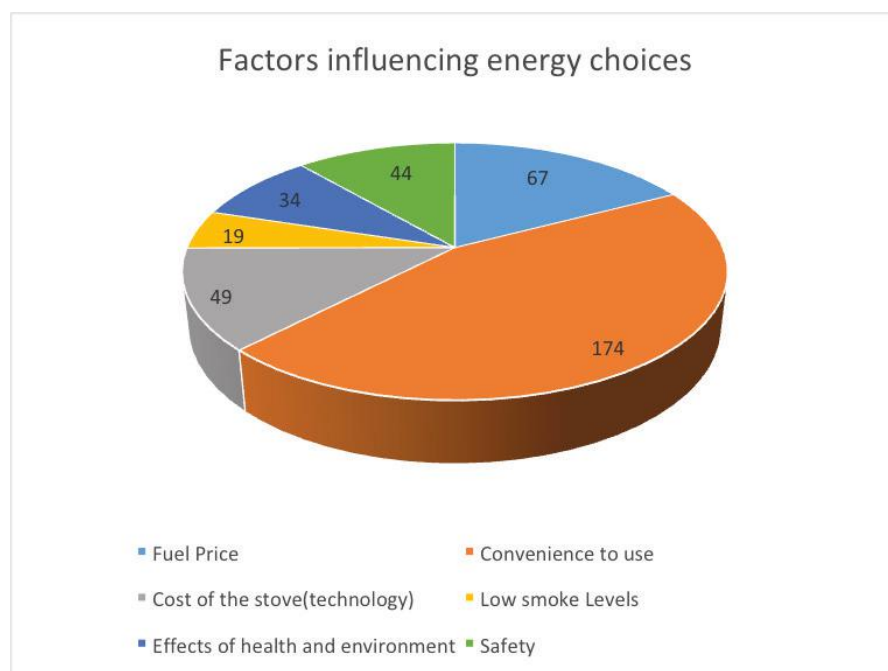
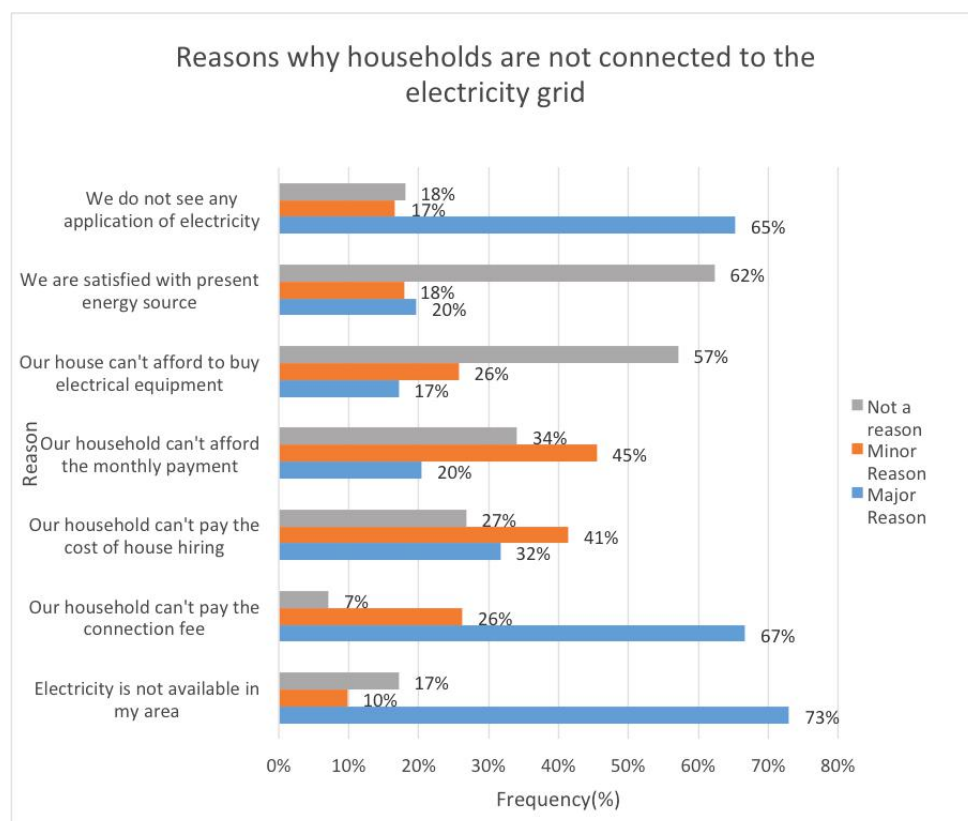


Figure 17 Convenience of use as a factor

Regarding connection to electricity, the reason why majority are not connected is because they are far away from power distribution lines and high connection fees. However, the payment of monthly bills was cited as not being a major reason which shows willingness of households to pay for electricity. Infrastructure development coupled with innovative financing can therefore promote rural electrification through grid connection or off grid solutions.



Institutions

The institutions sampled were drawn from agriculture, forestry and mining, manufacturing, construction, wholesale and retail trade, information and communication, education, human health and social work activities, arts, entertainment and recreational. 59.6% were from the education sector comprising of secondary, tertiary and vocational facilities. 21.3% were from health and social work and the least 2.1% are from Agriculture, forestry and mining, manufacturing and information and communication. Table 4 shows the distribution of the type of energy being used by the institutions. Firewood ranking is at 70 %, electricity at 58%, charcoal at 28% and solar energy at 26%, LPG is at 22% and finally diesel generator at 20%. There is very minimal usage of biogas by institutions.

FUEL	PERCENTAGE
Electricity	58
Charcoal	28
LPG	22
Solar Energy	26
Diesel Generator	20
Firewood	70
Biogas	0

Institutions have different energy needs and quantity consumed varies with population and size.

Health sector facilities in the county comprise of hospitals, health centers, dispensaries, nursing homes and private clinic estimated at a total of 255 .Energy needs range from cooling, lighting to operation of heavy medical equipment. The educational facilities include 1,336 ECD centers; 1,264 primary schools and 314 secondary schools. The county has 4 universities, 76 youth polytechnics and 15 commercial colleges. Hotels are estimated at 496.

Electricity

Electricity is the main source of energy for lighting in health facilities, businesses, and educational facilities in or near town centers, as well as research institutes and training facilities. Some of the electrical appliances mainly powered by grid electricity include radios, televisions, iron boxes, medical machines, air conditioners, refrigerators and information and communication technology equipment among others.

In terms of financing of electricity connection to institutions, 46.2% of the electricity supply has been funded by the county and national government as per table 5. 38% of the institutions had their own financing, costing from Kshs 15,000 to Kshs 60,000 while 7.7% were financed through external support.

Source of financing		Percent
	Institution expense	38.5
	Donation	7.7
	Government funding	46.2
	Other	7.7
Total		

Table 5 Financing Electricity connection

While maintenance cost remains low, poor wiring and frequent blackouts were associated with damaged cables, sockets and appliances. The laptop for schools programme was identified as one of the avenues that has facilitated electricity expansion programme.

Given the frequent power outages, most of the institutions especially hospitals have backup systems which is mainly diesel generator, solar lantern and panels or kerosene.

Firewood and charcoal

Firewood

Firewood continues to meet cooking energy needs for over 70 % of the institutions. Consumption levels vary with population and frequency of cooking activities. Some institutions reported using even up to 15 lorries annually or 2 lorries per month assuming each lorry is estimated to have a capacity of 1 tonne. Firewood is used between 2 hours and 15 hours depending on the cooking needs per day. While purchasing a lorry load in some areas cost Kshs 5000 or Kshs 6000, some can go as high as Ksh 10,000. In some cases, parents bring firewood as part of paying school fees.

Firewood accessibility varies from one location to another. Some institutions have to transport firewood from far distances raising the unit cost per tonne. There is also the constraint of obtaining firewood with low calorific values due to low quality or premature trees hence more firewood is used per cooking cycle.

Some institutions have adopted improved cooking technologies that are more efficient and save on firewood and retain heat as shown in figure 17. The price of the stoves was noted to be in the range of Kshs 100,000 depending on the supplier



Figure 17 An institutional cook stove

Charcoal

From the study, 28% of the sampled institutions use charcoal for cooking, either as a primary or secondary source of energy depending on the type of institution. A hotel reported using an average of 4 sacks per month and with the average cost of a sack estimated to cost Kshs 900. The number of hours charcoal is used in institutions varies between 2 hours and 8 hours. A number of institutions noted that there has been a slight change in prices of charcoal but the bigger concern was the change in the quality of charcoal. This was associated with harvesting trees of low calorific value and high demand for charcoal where suppliers take the good quality charcoal to other towns like Nairobi.

Unlike the improved firewood institutional jikos, institutions noted charcoal jikos are usually very small. Hence the option of using normal metallic jikos available in the markets which are easy to order from local artisans and come in different sizes.

LPG

Institutions like hotels and other businesses use LPG for cooking. Commonly used are the 13 and 22kg cylinders. The commodity is more accessible due to an increase in supplier companies although in some areas the refill points are as far as 44 km away from some institutions.

Solar

Adoption of solar PV systems and micro solar home systems by institutions stood at 22%. 67% of the institutions have been supported by county or national government, 16% acquired their own financing while 17 % was through other sources of financing including donation.

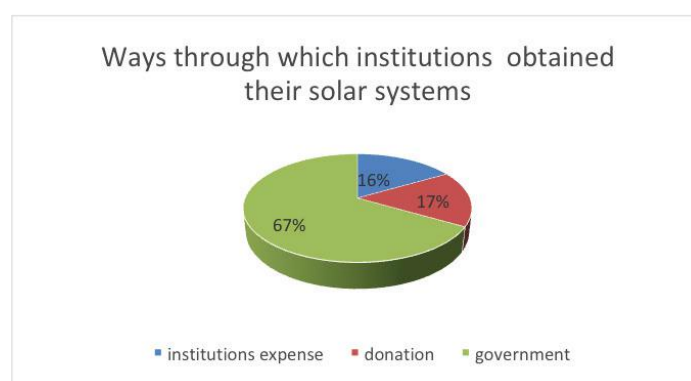


Figure 19 Modes through which solar systems were obtained

Solar systems are mainly for lighting or powering appliances like TV, Computers, printers and phone charging. While some institutions use it as the only source of energy, others use it as back up. In some institutions, sizing of systems does not match the power needs, hence the need for sensitization on solar system sizing and availability of technical skills to follow up with maintenance.

Diesel Generator

The generators are mainly in schools, hospitals, hotels and other business premises as the main source of electricity or for back up purposes. For institutions who have utilized generators for over 10 years, the cost of running was noted to be high especially with the increase in retail oil prices. One hotel reported use of up to 60 litres per day during black out. Despite the cost element, institutions felt that business always continues during black out since fuel is always available at the petrol stations. Noise and smoke pollution was noted as a drawback to this technology. With time, generator technologies were noted to have improved and the current ones are more fuel efficient

3.0

Energy Resources Potential

Kitui County is endowed with energy resources that are currently utilized while others are in the process of exploitation. To meet the economic development objectives and the energy needs, further development and exploitation of these resources will be crucial. The resources described here include solar, wind, biomass and coal.

Solar

Temperatures experienced in Kitui County range between 14 °C and 34 °C that provide good insolation all year round. The county has an annual average irradiation of 1400-1600 kWh/m²; this translates to a total of 45GWh of solar power potential per year. As depicted in figure 19 and 20, the eastern part of the county, receive an irradiation of above 2200 kWh/m², while northern part of the county including sections of Waita, Kyuso, Kwa Vanza regions experience an irradiation of over 2300 kWh/m². Some sections like Kauwi are noted to experience irradiation of over 2500 kWh/m².

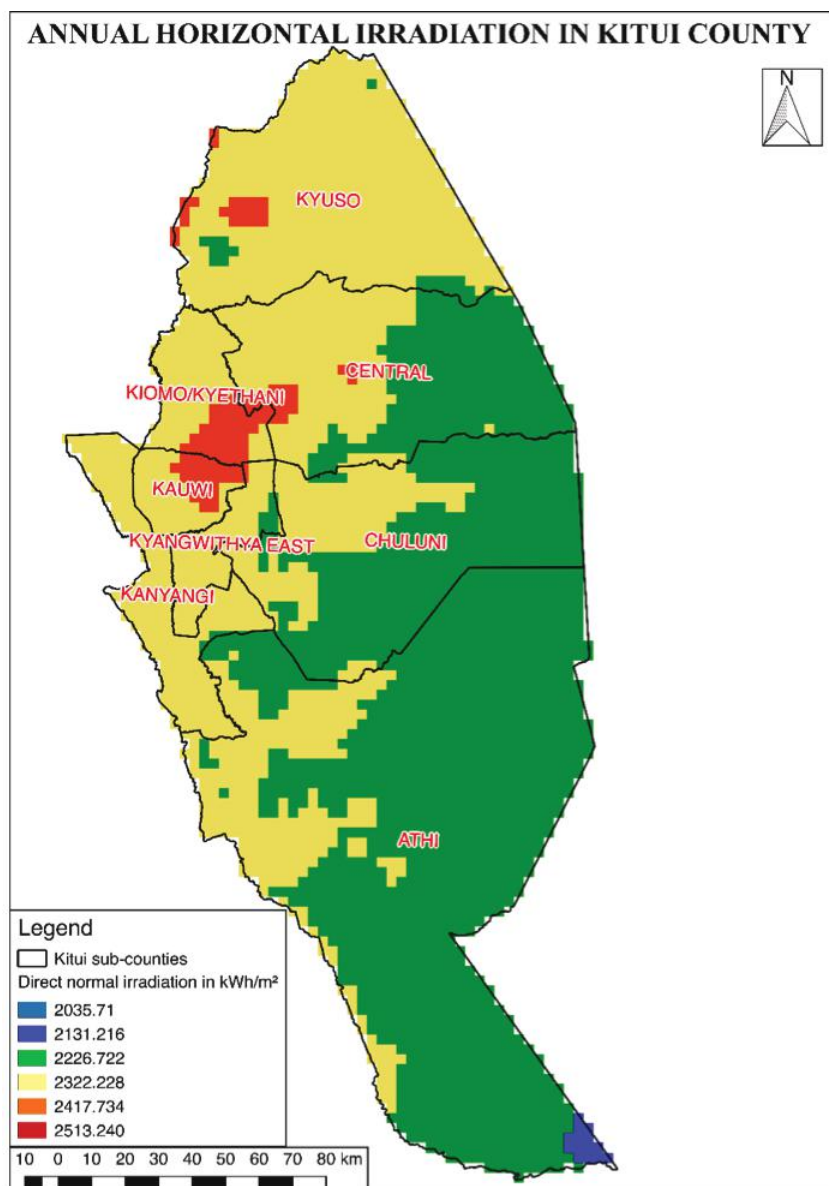
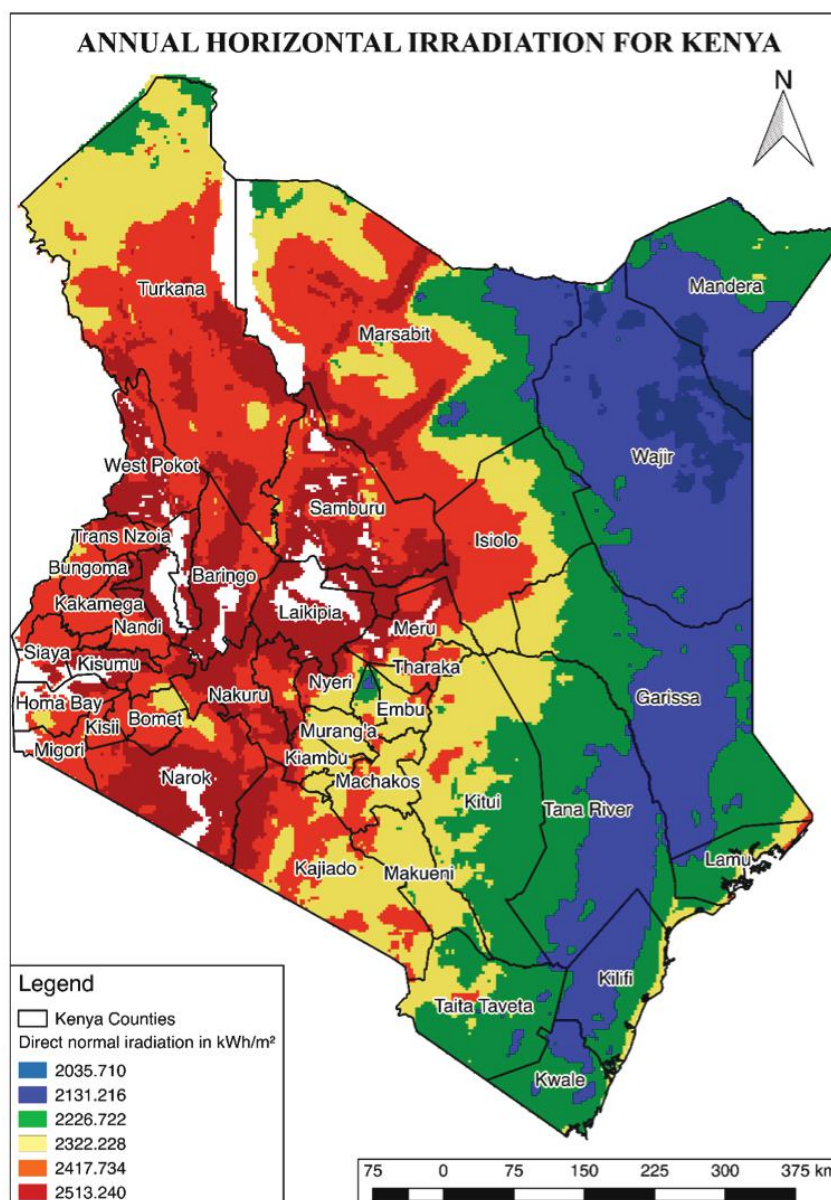


Figure 20 Kitui County map showing irradiation values



Wind

The topography of Kitui County is characterized by hills and ridges in areas such as Mumoni of Mwingi North Sub County, Mutitu of Kitui East Sub County, Mutha of Kitui South Sub County and the plains of Kitui Rural Sub County. These hills and ridges are very essential for providing the channeling effect making them suitable sites for the investment in power generation using wind Energy technologies. A study conducted in 2013 on the wind energy potential in the Mwingi_Kitui plateau gave promising results regarding the potential of the county in terms of the wind energy resource. The plateau has an annual wind speed of 4.24 m/s at 20 m and wind speed direction being from south east. This makes the region suitable for operation of small wind turbine electricity generators. Stand-alone wind systems or hybrid systems would be recommendable to power rural homes in the county

Data sets from International Renewable Energy Agency (IRENA), 3TIER's Global Wind Dataset indicated that close to 75% of Kitui county regions experience average annual wind speeds of over 6.5 m/s while the rest fall under 4-5m/s at 80 meters above the ground level as shown in figure 20 and 21.

To promote wind energy development on a commercial scale, the government has feed in tariff (FIT) policy to attract private investment. The FIT policy provides a fixed tariff of US \$ Cents 11.0 per kilowatt-hour of electrical energy supplied in bulk to the grid operator at the interconnection point. This tariff applies to wind power plants (wind farms) whose effective generation capacity is above 500 kW and does not exceed 100 MW.

Mwingi region and Yatta plateau are potential sites for commercial scale wind projects. In other regions, local communities have invested in mechanical wind systems for water pumping – a technology which potentially can be up-scaled to improve access to water.

In order to provide more information to stakeholders and potential investors, wind campaigns / measurements for a period of 3 years will thus be crucial in order to help determine wind speeds at different heights in addition to carrying out site feasibility studies.

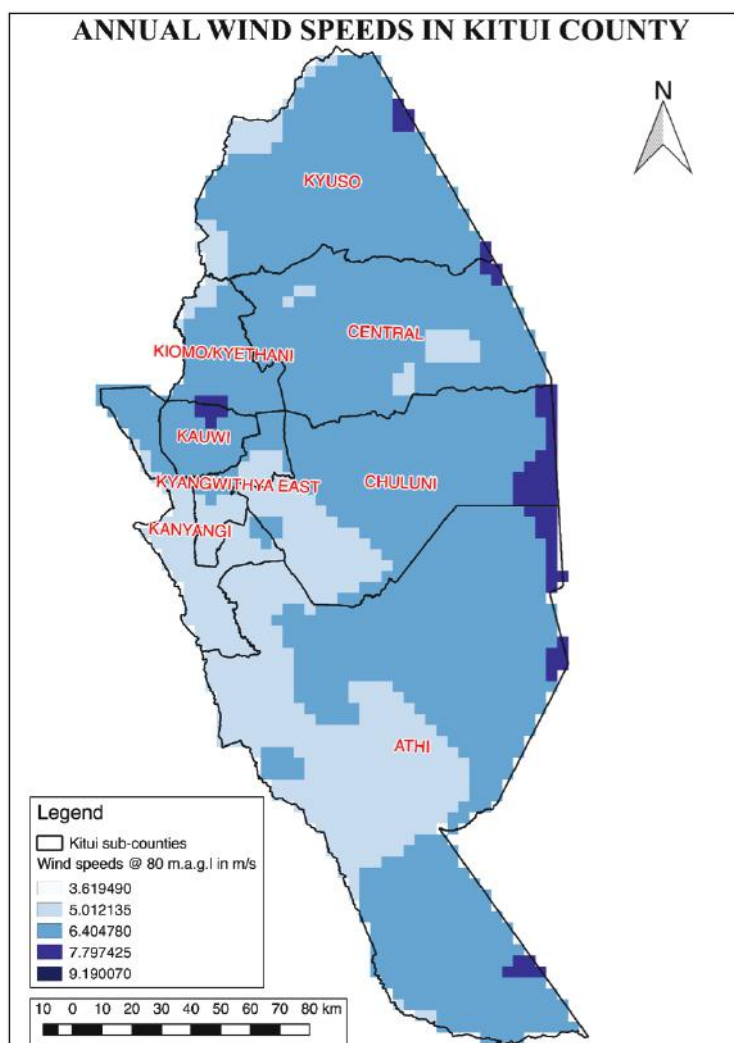


Figure 22 Kitui County Annual Wind speeds

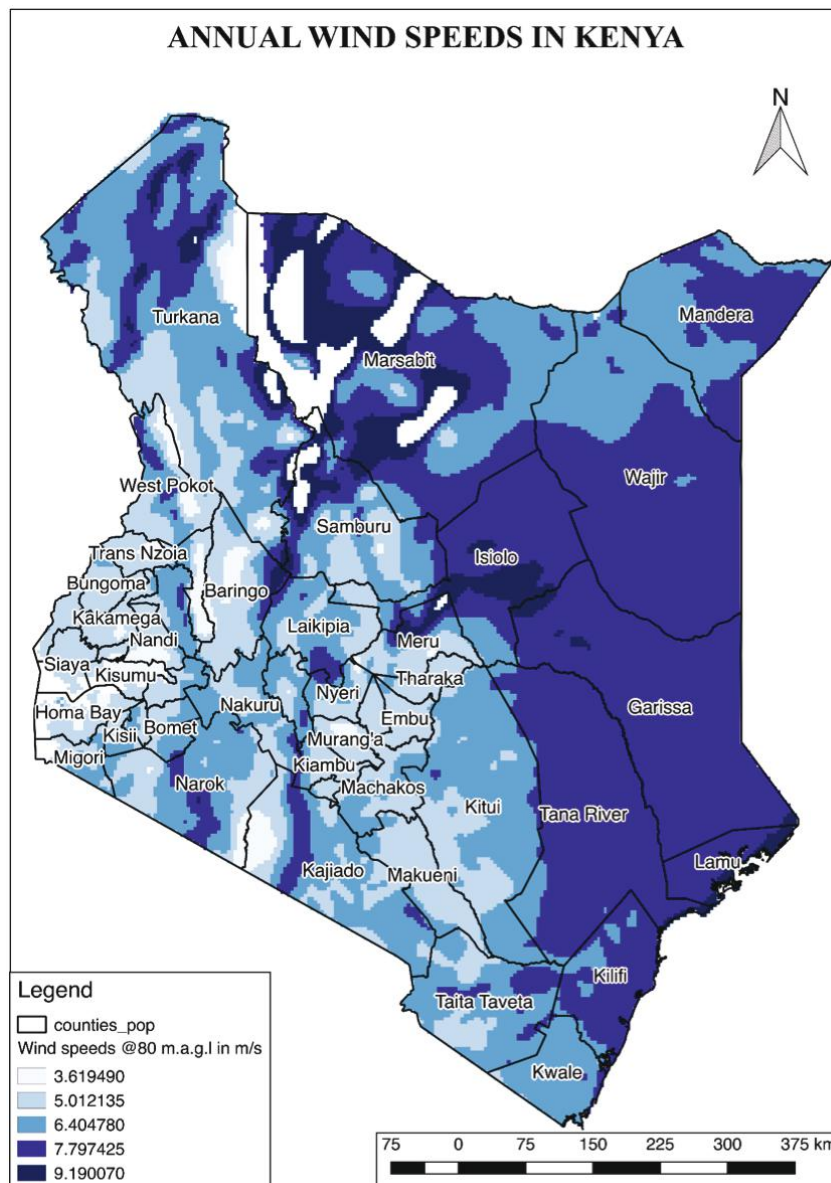


Figure 23 Kenya annual wind speeds

Biomass

Biomass is mainly consumed in the form of firewood and charcoal but there are other forms like crop residues, pellets, briquettes or animal dung which provide energy needs for cooking, heating, drying or electricity production. Biomass energy resources are derived from forests - closed forests, woodlands, bush lands, grasslands, farmlands and plantations as well as from agricultural and industrial residues. Currently there is a growing imbalance between biomass energy supply and demand, with a deficit of almost 60%. This imbalance exerts considerable pressure on forest and vegetation stocks and accelerates the processes of land degradation and desertification.

The supply potential for Kitui County is estimated at 266,777m³ for firewood and 143,426 m³ for charcoal while the demand stands at 490,557 m³ and 428,212 m³ for firewood and charcoal respectively. This leaves a negative net balance of 508,342 m³.

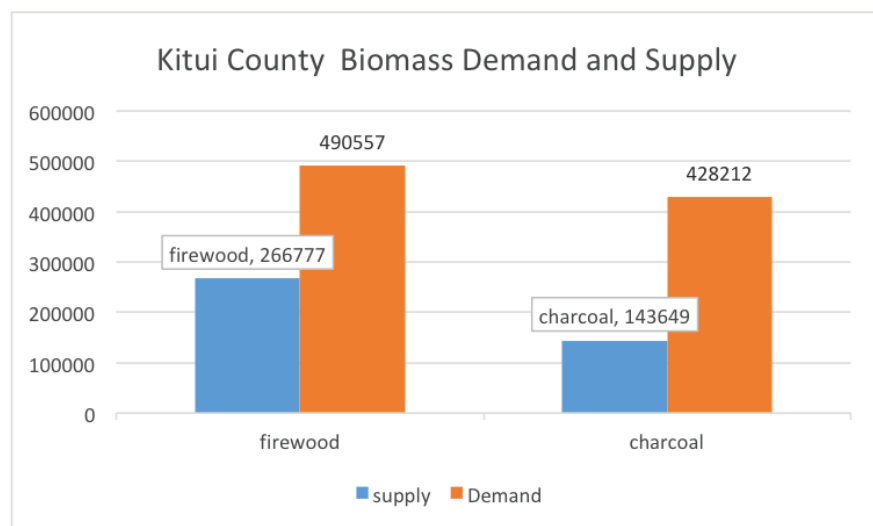


Figure 23 Biomass demand and supply

Forestry and Agro Forestry

The County has 14 gazetted and 15 ungazetted forests covering an area of about 35,592.6 Hectares in total under different forms of ownership as shown in table 6. Forests play a key role in providing wood and non-wood products, water conservation, ecosystem protection and habitat for wildlife.

Gazetted forests		Ungazetted forests	
Name	Area (Ha)	Name	Location
Kabonge	31.80	Ilima Yimwe	Yatta
Kyawea	63.10	Kwa Vonza	Yatta
Museve	42.20	Mwakini	Yatta
Mutuluni	596.00	Maathani	Yatta
Mutitu	1,958.00	Kiongwe	Chuluni
Endau	6,717.80	Kivongo Valley	Central
Makongo	3,431.80	Mataitho	Central
Engamba	2,142.00	Nzanzu	Nuu
Nthoani	1,387.00	Nzia	Mutitu
Mutha	1,361.00	Maimu	Mutomo
Mumoni Hills	10,522.90	Kyongoani	Chuluni
Gaikuyu Hills	30750	Nzaayani	Chuluni
Imba/Kyui-kuyu	732.00	Mutaitho	Mwingi East
Nuu	3,532.00	Mai	Mwingi East
		Kyui	Mwingi East
TOTAL	35,592.6		

Table 6 Gazetted and the Ungazetted Forests in the Kitui County

Source: KEFRI Information Bulletin No. 3: 2009

Value of Charcoal

Charcoal is preferred due to its portability and convenience as a business commodity. When firewood is converted to charcoal, there is value addition. For instance, sale of one ton of wood will fetch Ksh. 1000. If the same quantity of wood is converted to charcoal in a modern kiln, it will produce 300 kilograms of charcoal. This will produce about 7.5 bags of charcoal each weighing 40 kilograms. At the market price of Ksh. 500 (2013) in the rural areas, this will fetch about Ksh. 3,750. In urban areas, the price is about Ksh. 1,300 per bag. It will therefore fetch about Ksh. 9,750.

Approximately 11,000 bags are harvested per month through the registered charcoal and transporter groups.

Coal

Coal is classified as a mineral fuel by the mining Act, 2016. Kitui County has coal deposits in the Mui basin, spread from block A of Zombe/Mwitika Ward to block D in Kivou/Ithumbi Ward to an approximate 500 Km². The prospecting of Coal in the Mui basin was done by the Ministry of Energy and Petroleum (MoEP) and was completed in 2014 with quantification of the coal deposits in block C found to be more than 400 million MT of coal reserves valued at Ksh3.4 trillion (\$40 billion). In December 2013, the Coal blocks C & D were concessioned to Fenxi Mining Industry Company of China and Great Lakes Corporation of Kenya. Later blocks A and B were concessioned to Liketh and HCIG in 2015.

The County has put in place initiatives to support mining such as construction of link roads to Mui coal basin and other mining areas to ease movement of people, goods and services. These link roads have been done with construction of all-weather road networks across Mui ward.

Coal mining – in particular open pit as planned for Mui - has a strong environmental and social impact and considerable pollution. The mining will require large scale resettlement measures. Further, mining itself will produce considerable pollution. Necessary measures ought to be put in place to address the concerns.

4.0

INFRASTRUCTURE AND INITIATIVES

Grid extension

Grid extension – transmission and distribution-offers an opportunity for delivering reliable grid electricity to end users with minimal interruptions as well as an opportunity for independent power producers to evacuate power if produced locally.

In partnership with Rural Electrification Authority (REA), the county government is working to ensure the rural electrification programme is actualized and towards a 100% connectivity. During the 5 years strategic period (2013-2017), the county government funded the construction of Kalwa-Ndunguni- Ndatani-Kwavoto power line, and from Ngomeni Town to Ngomeni Rock water catchment both in Ngomeni ward and in Mwingi North sub-county. Construction of power line from Ukasi Market-Kakitya market- Kamaende ECD, both in Mwingi Central Sub County is ongoing.

In order to enable enhanced access to the national grid, the Kenya Electricity Transmission Company(KETRACO) has plans to construct various feeders of higher capacities. The 560km 400kV Lamu-Kitui-Nairobi East double circuit line under the power evacuation project is being implemented. It targets to evacuate power from various generation plants into the national grid. The 153km 132kV feeder to serve Mwingi-Kitui-wote-Sultan Hamud line under the electricity access projects targets to increase energy access and address challenges of low connectivity. This feeder will have substations in Mwingi, Kitui, Wote and Sultan Hamud. There's also construction of 250km 132kV Kindaruma-Mwingi-Garissa line which will cross over three counties including Embu, Kitui and Garissa. Substations are used to convert high voltage electricity transmission to lower voltages for consumer usage.

The Kenya National Distribution master plan outlines plans to enhance distribution across the country which includes construction of distribution and feeder lines, sub-stations and installation of transformers.

KETRACO 132kV - 500kV TRANSMISSION LINES AND SUB-STATIONS

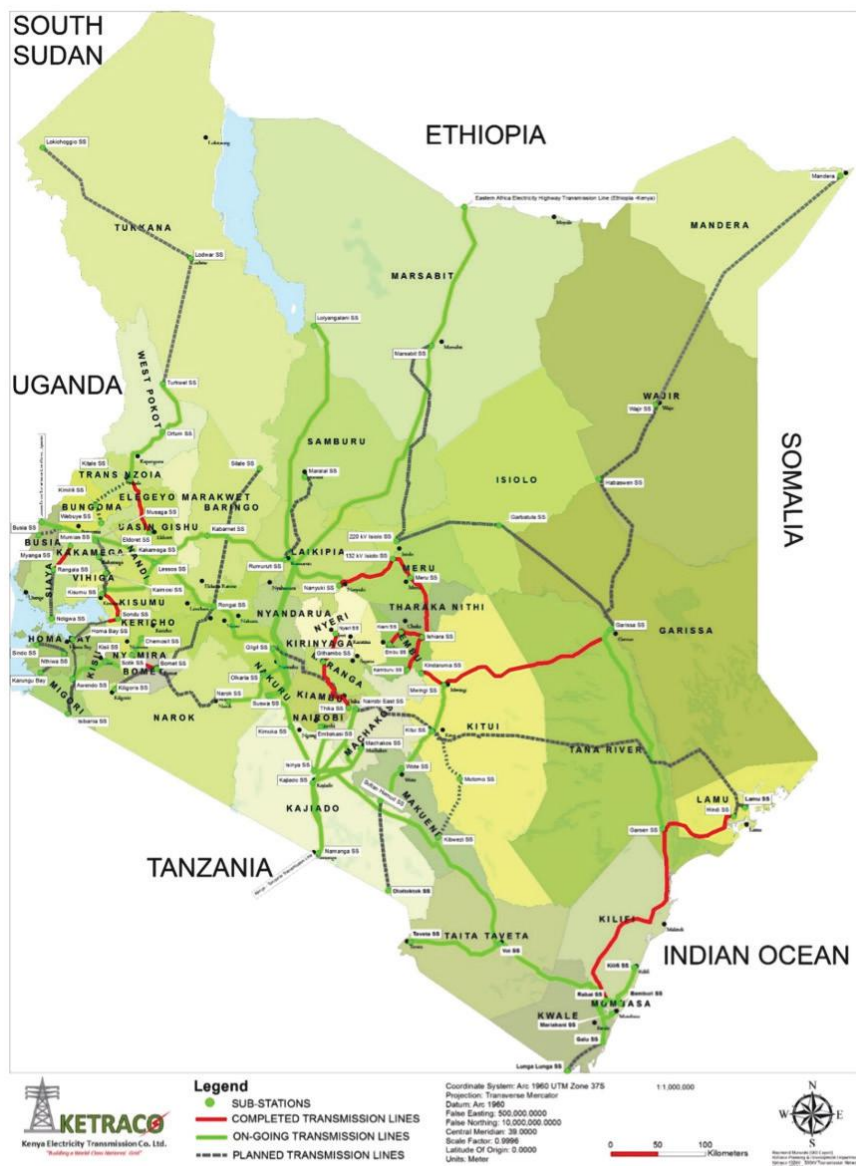


Figure 25 KETRACO Transmissions lines Network

Connection to electricity

Between June 2013 and May 2017, over 153,000 people gained access to electricity.

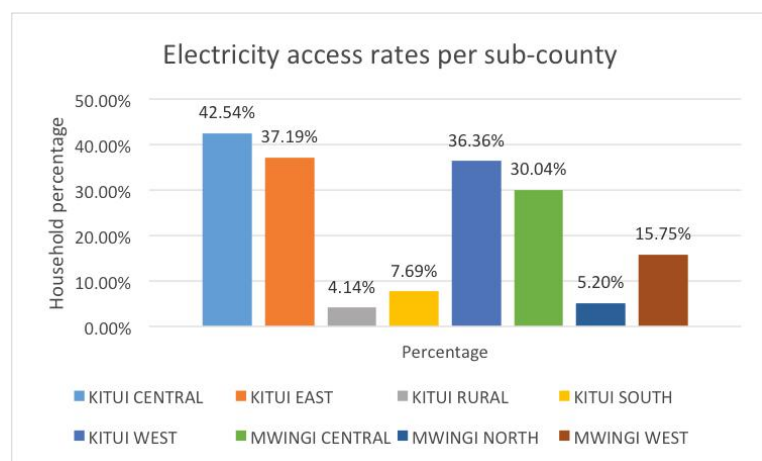


Figure 25 Rate of electricity access for sub-counties.

Kitui central has the highest rate of access at 42.54 % representing 10,206 households, Kitui East follows with 37% , Kitui West at 36.3% and Mwingi Central at 30%. The least household numbers are within Kitui South, Kitui Rural and Mwingi North at 7.69%, 4.14% and 5.2% respectively. The county rate of electricity connections is approximately 21.68%.

At institutional level, schools, hospitals, markets and other enterprises have access to electricity. Out of the 1,411 primary schools, 804 are connected to the national grid while 589 have access to solar Pv systems as shown in figure 25. The rate of trading centers electricity access stand at 39%, 46.96% for secondary schools and 33.1 % for health facilities

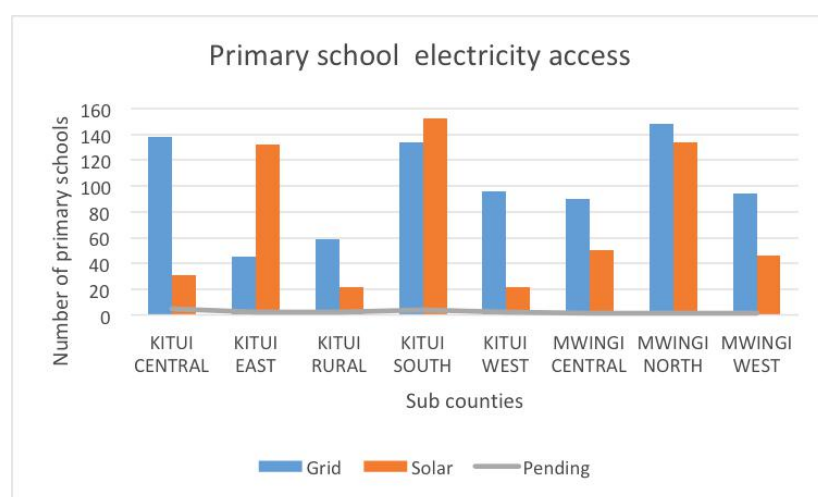


Figure 26 primary school access to electricity

Solar sector development

Lighting market centers: The County Government has so far installed solar security lights in all the 40 Ward headquarters and 153 upcoming markets and small shopping centers. The installation was undertaken in three phases; during phase 1 of the project, 5 solar lights were installed in each of the 40 ward headquarters. In phase 2, solar lights were installed in 39 markets in the 40 wards while in phase 3, an additional 329 solar lights are being installed in several smaller markets across the county.

Solar for institutions: The national government through the Rural Electrification Authority (REA), in collaboration with the county government has been undertaking power reticulation in rural sections especially in schools. The programme started in 2012. The sizing of the solar systems is done according to the estimated power needs. As shown in figure 26, some of the health facilities had solar systems ranging between 440 and 3360 Watt peak.

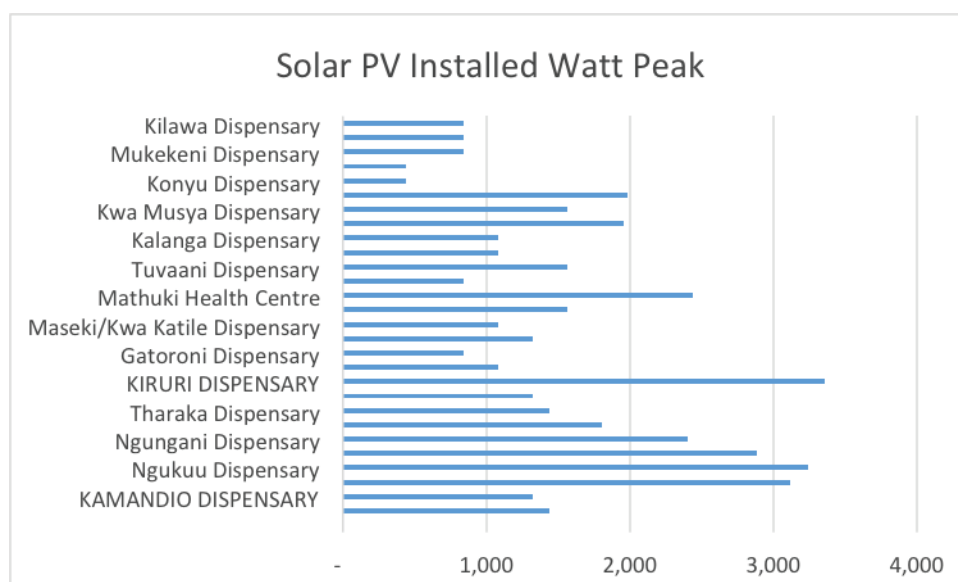


Figure 28 Health facilities Solar PV sizes

Proposed Solar power plant: County Government of Kitui has signed a partnership agreement with Loop Japan Inc. to establish a 40MW solar power plant in Kitui. The proposed power plant will be situated on a 210 Acre piece of land at Kanyoonyoo in Kitui Rural, land owned by the County Government.

Innovative delivery models: Working in collaboration with partners like Trocaire, CAFOD, Irish Aid, and Department for International Development (DFID), Caritas -Kitui is engaging communities to acquire solar lanterns and micro solar home systems through innovative financing. Working through common interest groups, a needs assessment is conducted and solar products are supplied to the group leadership. Through the saving and loans approach, each group member who obtains the solar lantern is required to save Kshs 100 per week which the household could have used to purchase kerosene, in a months' time each member saves Kshs 400. The group then continues to build a revolving fund which enables them to acquire more solar products for all the group members. Over 300 micro solar home systems were sold between January and December 2017.

Solar products retail and distribution: This study undertook a survey to assess the solar

products available in the retail shops in Mwingi Kitui and Mutomo towns. Over 7 solar PV models were identified either in retail or distribution shops. Some include models by Chloride Exide; Ubbink/Sollatek; Solar Land and Power Mate with panel ranging between 20 watts and 200 watts. The inverters were 4 models as shown in table 7 ; 6 charger controllers and 5 batteries ranging between 30 and 200 Ampere Hours at an approximate cost of Ksh 5,800 and Ksh 28,000 respectively.

Inverter Model	Rating(W)	Price (Kshs)
Model A	150W	2,500
Model A	350W	3,000
Model A	600W	4,500
Model B	150W	2,500
Model B	300W	3,500
Model B	600W	4,500
Model B	1500W	15,000
Model B	2,000W	20,000
Model B	3,000W	30,000
Model C	1200W	18,000
Model C	1600W	24,000
Model D	300W	6,800

Table 7 Inverters and their market prices

Promoting biomass sustainability

A well-managed charcoal industry contributes to job creation, environmental conservation and improved economy. The Charcoal Management Act of 2014 aims to contribute to poverty reduction, employment creation and improved livelihoods through sustainable use, conservation and management of forests and trees. This will be achieved by promoting participation of the communities, private sector and other stakeholders in forest management; promote dry land forestry to produce wood fuel, charcoal and non-wood forest products; and ensure sustainable charcoal production.

- Organized production and transportation groups: To enhance sustainability in the county charcoal sector, only registered Charcoal Producers Associations and Charcoal Transporters Associations are required to undertake the production and transportation business.
- Capacity building: The county government and other stakeholders like Kenya Forest Service; Kenya Forestry Research Institute (KEFRI), Caritas Kitui have undertaken capacity building activities to sensitize and equip the charcoal producer Associations with sustainable charcoal management and business skills.
- Efficient wood conversion technologies: Due to inefficiency of the earth kilns, modern kilns were introduced by Kenya Forest Service (KFS) and the Kenya Forestry Research Institute (KEFRI). Casamance, Half-Orange, drum kilns and metal kilns are some of the piloted

technologies and under use for instance in Kandae village, Mutomo. When well designed and operated, modern kilns have the potential of achieving between 25-35% conversion efficiency. The county government in collaboration with stakeholders is continuing to support acquisition of these technologies and also promoting sustained use and wider adoption.

- d. Efficient cooking solutions: Activities are being undertaken to promote wider use of efficient cooking jikos. The Kitui Energy center and the county government are collaborating to create awareness to end users as well as in training artisans. Caritas Kitui has been promoting both domestic institutional cook stoves like rocket stoves. Promotion of the use of energy saving jikos including the rocket stove, Kenya Ceramic jiko and the Maendeleo jiko. Caritas project have been training artisans who in turn reach out to households. This project that has a carbon credit aspect through the Gold Standard mechanism with a target of 15,000 stoves between 2014 and 2017. The project co-finances technical fee while households source for bricks, sand and ballast. Institutional cook stoves save quantity of firewood used per cooking cycle. For instance a school in Mwingi reported reducing the consumption per term from 4 pick-up loads to 2 pickup loads.
- e. Briquettes: There is promotion of the use of briquettes made from charcoal dust in Voo/ Kyamatu ward. Though this activity was noted to be very minimal – the county has potential of undertaking briquette making activity for domestic and institutional use.



Figure 28 Half-orange Kiln; Drum kiln; Metal kiln and Casamance kiln

5.0

Energy policy and regulatory framework

This section highlights policies, legislations and institutions governing the Kenya energy sector at a national level and which the county government is working closely with:

Sessional Paper No. 4 of 2004: The Sessional Paper No. 4 of 2004 is a policy document that stipulates the liberalization reforms implemented in the energy sector in the mid-1990s. Its vision is to promote equitable access to quality energy services at least cost while protecting the environment. The paper therefore lays down the policy framework upon which cost effective, affordable and adequate quality energy services will be made available to the domestic economy on a sustainable basis over the period 2004-2023.

Energy Act No. 12 of 2006: One of the main proposals of the Sessional Paper was the enactment of an Energy Act to succeed the Electric Power Act No. 11 of 1997 and the Petroleum Act, Cap 116 of 1994 to facilitate a single platform for regulation and enhancement of all energy resources in the country. It further provides for the establishment of Energy Regulatory Commission (ERC), The Energy Tribunal and the Rural Electrification Authority (REA). The Act also outlines the functions and powers of these bodies. The other Acts that impact the energy sector include:-

The Standards Act, Chapter 496 of the Laws of Kenya that provides for establishment of minimum quality specifications, mode, materials and apparatus for energy used in the country.

The Environmental Management and Co-ordination Act, 1999, regulates the environmental aspect of the energy sector.

The Physical Planning Act, Chapter 286 of the Laws of Kenya that provides for zoning of areas for storage, distribution and retailing of petroleum fuels and construction of electric power sub-stations and other infrastructure.

The County Government Act that provides for the regulation required to implement the provisions relating to devolved government and to give effect to chapter 11 of the Constitution, to provide for county government powers, functions and responsibilities to deliver services and for connection purposes.

Feed-in Tariff (FiT) Policy: Introduction of feed-in tariffs (FiT) in 2008 was to provide investment security to renewable electricity investors, reduce administrative and transaction costs and encourage private investors in establishment of Independent Power Production (IPPs). The FiT were reviewed in 2010 and 2012. The tariffs apply to grid-connected plants and are valid for a 20-year period from the beginning of the Power Purchasing Agreement (PPA), with approval of the PPAs granted by the ERC.

Institutional arrangement

The following are the key actors in the sector:-

Ministry of Energy and Petroleum (MoEP) is responsible for formulation and articulation of energy policies through which it provides an enabling environment for all stakeholders

Energy Regulatory Commission (ERC) is responsible for the economic and technical regulation of electric power, renewable energy, and downstream petroleum sub-sectors. Its functions also include tariff setting, review, licensing, enforcement, dispute settlement and approval of power purchase and network service contracts.

The Kenya Power is a State Corporation with GoK shareholding of 50.1% and private shareholding of 49.9% as at December 2011. It off takes electricity in bulk from power producers and carries out distribution.

Kenya Electricity Generating Company Limited (KenGen) is a State Corporation with GoK shareholding of 70% and private shareholding of 30% as at December 2011. It is mandated to generate electric power, currently producing the bulk of electricity consumed in the country. The company utilizes various sources to generate electricity ranging from hydro, geothermal, thermal to wind.

Rural Electrification Authority (REA) was established under section 66 of the Energy Act of 2006 as a body corporate with the principal mandate of extending electricity supply to rural areas, managing the rural electrification fund, mobilizing resources for rural electrification and promoting the development and use of renewable energy.

Geothermal Development Company Limited (GDC) is a 100% state-owned company established by the Government of Kenya as a Special Purpose Vehicle for the development of geothermal resources in Kenya.

Kenya Electricity Transmission Company Limited (KETRACO) is a GoK wholly owned company established to be responsible for the development, maintenance and operation of the national transmission grid network.

Kenya Petroleum Refineries Limited (KPRL) is a limited liability company with its main business being processing of crude oil, with a name plate capacity of 4 million tons per annum.

Kenya Pipeline Company Limited (KPC) Its business is mainly storage, transportation and handling of refined petroleum products in the country.

National Oil Corporation of Kenya Limited (NOCK): is mandated to stabilize the petroleum supply market by participating in all aspects of the petroleum industry namely upstream, mid-stream and downstream activities.

Kenya Nuclear Electricity Board (KNEB) is charged with the mandate of spearheading and fast tracking development of nuclear electricity generation in order to enhance the production of affordable and reliable electricity.

Centre for Energy Efficiency and Conservation (CEEC): champions energy efficiency and conservation efforts in Kenya.

Oil Marketing Companies (OMCs) are local and international companies licensed to undertake the importation, storage, wholesale, export and retail of petroleum products.

Petroleum Institute of East Africa (PIEA): It plays a key role in capacity building and awareness creation in the petroleum sub-sector.

Oil Exploration and Production Companies (OIEPs): These are local and international companies licensed to undertake exploration and production of petroleum products.

Other key players in the energy sector include National Environmental Management Authority (NEMA), Kenya Revenue Authority (KRA), Kenya Railways Corporation (KR), Kenya Truckers Association (KTA), Kenya Association of Manufacturers (KAM), Kenya Maritime Authority (KMA) and Consumers.

This policy has developed framework which forms the basis for sharing of the benefits. One of the benefits to be equitably shared is the government share of profits accruing from energy natural resources to be implemented between the years 2014 to 2018. These shall be shared as follows:-National government (75%), County government (20%) and Local communities (5%).

Some planning documents include:

Least Cost Power Development Plans (LCPDP) : The Least Cost Power Development Plans (LCPDP) have been the Ministry of Energy and Petroleum (MoEP's) power implementation plan for delivering the power sector targets outlined in Vision 2030, prepared by the Planning Team. The main contents are demand forecast scenarios for electricity demand, assessment of energy resources and generation and transmission expansion plans for the respective study periods.

Rural Electrification Master Plan: This is the master plan for the electrification of rural areas through the rural electrification program. It is updated on an annual basis in order to respond to the most urgent needs of rural population regarding electricity connectivity. The main agency responsible for this is the Rural Electrification Authority (REA) which was established by the Energy Act of 2006, and operationalized in 2007 with the sole mandate of accelerating rural electrification in Kenya. The government of Kenya provides the main funding sources for REA projects (80%) and is supported by various development partners (20%). The projects completed by REA are handed to KPLC for operation and maintenance based on a Service Level Agreement (SLA). However, the projects continue to remain the property of REA and it does not pay KPLC operation and maintenance costs of the projects as this is recovered through the electricity retail tariff.

5.1 Kitui County Energy Development Sector

To improve energy access to most households, Kitui County envisages to embrace renewable energy strategies. The County government shall put in place deliberate measures to ensure conservation and protection of the water catchment areas. There will be sensitization campaigns in the county pertaining to the importance of conserving the environment.

The use of renewable energy and energy efficiency projects will be implemented and Kenya Power will expand power connectivity in the County. Coal deposits at Mui basin in Mwingi Central constituency is among the national flagship projects geared towards realization of Kenya Vision 2030

Objectives for Kitui County energy department

- Enhance rural electrification in conjunction with Rural Electrification Authority (REA) and Kenya Power
- Increase access to alternative energy sources to households and institutions within the County
- Identification of renewable energy sites for development.
- Formulation and review of County specific policies on renewable energy.
- Developing and enacting legislations and regulatory framework for County specific policies on renewable energy.
- Implementation of county policies and legislations related to renewable energy.
- Enforcement of the energy policies, regulations, laws and compliance with management measures within the county.
- Provision of information and updates on renewable energy issues to the county executive and legislative arms.

-
- Facilitate research, adoption and capacity building on sustainability and utilization of renewable energy.
 - Promote partnerships to support distribution and provision of affordable rural electrification and sustainable secure renewable energy.

5.2 Stakeholders

The following are the key stakeholders the ministry will continue working with and the roles the stakeholders are expected to play.

- a. National and County Government: Formulation of mining, waste management, tree growing, energy and climate change policies and legal framework.
- b. Kenya Forest Service (KFS): Offer technical backstopping on afforestation.
- c. Kenya Forestry Research Institute (KEFRI): Development and dissemination of forest technology, research on drought tolerant tree species.
- d. National Environment Management Authority (NEMA): Offer technical backstopping on regulation and enforcement of environmental laws and legislations.
- e. Water Resources Management Authority (WRMA): Develop community capacities to actively participate in water catchments and riverine ecosystems rehabilitation.
- f. National Drought Management Authority (NDMA): Develop capacity of County Climate Change Committee to manage County Climate Change Adaptation Fund.
- g. Kenya Meteorological Service: provision of timely weather forecast and support County Climate Change Information System (CIS) and
- h. South Eastern University College (SEKU): Help in Mapping and documentation of mineral resources in the county.
- i. Rural Electrification Authority (REA): Facilitate expansion of electricity infrastructure especially in rural areas.
- j. Kenya Power: Ensuring power supply through connectivity.
- k. Community Forest Associations (CFAs): Afforestation and reforestation of degraded ecosystems.
- l. Charcoal Producers Association (CPAs): Regulation of charcoal production in the county.
- m. Kitui Energy Centre (Ministry of Petroleum and Energy): Perform demonstrations on the clean and safe production of solar energy.
- n. NGOs and CBOs- Awareness creation and sensitization of sustainable development and environmental conservation.
- o. Private Sector: resource mobilization and investments.

6.0

FUTURE DEVELOPMENT PLANS AND
THE IMPACT ON ENERGY SECTOR

Sector and energy needs

Kitui Vision for Economic and Social Transformation (KIVEST, 2015) and the CIPD (2013-2017) which is under revision have outlined sector activities that are targeted to boost economic and social development and achieve 10% growth in GDP. This section gives an overview of some of the activities and possible energy needs:

Sector	Identified plans
Agriculture:	<p>To boost agricultural productivity, priority areas include expansion of land under irrigation through the Athi -Kilawa irrigation project and other projects in the County .Currently 2000 hectares are under irrigation and the target is to hit 4656 Ha.</p> <ul style="list-style-type: none"> • Grid electricity; Solar or wind energy for water pumping and irrigation would play a key role in driving the agriculture sector. • Farm mechanization will require more fossil fuel like diesel to run farm machinery • Value addition. Energy for food processing and storage can be provided through grid electricity; off-grid solar and wind energy. Aspects of solar drying will also play a great role.
Health and Sanitation	<p>There are 255 health facilities spread across the entire County. The County Government is committed to the expansion and provision of modern health care services in all its health facilities. The referral hospitals will be equipped with ultra-modern CT scans and dialysis machines. An Intensive care unit, Hospice, Psychiatric unit and Maternity theatres will also be established in the 40 wards. More reliable electricity and backup generator systems will be a requirement while small health facilities can be equipped with wind or solar power.</p>
Water Development and Supply	<p>The County has several dams and water pans that play a significant role in providing water, such as Kalundu Dam. Most of the dams dry up during the dry season due to the high evaporation.</p> <ul style="list-style-type: none"> • There is potential for water pumping and storage ;wind water pumping; Solar and grid electricity; Diesel pumps
Urbanization	<p>Urbanization will lead to increase in residential units; commercial enterprises and more road transportation.</p> <ul style="list-style-type: none"> • Energy for running the businesses; heating and cooking in the domestic and commercial enterprises, this will lead to demand for biomass resource, LPG; diesel and petrol; electricity
Education	<p>Kitui County has 1,336 ECD centers; 1,264 primary schools; 314 secondary schools; 76 youth polytechnics and 15 commercial colleges and four universities:</p> <p>There is energy demand for lighting, cooking, heating, facilitating research and running ICT equipment's.</p> <ul style="list-style-type: none"> • This can be supplied through biomass; LPG; wind; solar; grid electricity. Demand for transport is expected to rise as population/enrollment in this institution continues to grow.
ICT	<p>To promote the development of ICT in the County, the government plans to establish ICT incubation hubs with high speed internet connectivity that will be a Centre for innovation of ICT market- ready services and products.</p> <ul style="list-style-type: none"> • These centres will require reliable grid power; solar or wind energy.
Coal mining and power plant	<p>The Power Generation and Transmission master plan 2015 to 2035 proposed development of a coal power plant in Kitui county in 3 units be constructed between year 2015 and 2027 in order to contribute in meeting the national power needs.</p> <ul style="list-style-type: none"> • Coal mining activity and associated development will require more energy for running machinery; grid electricity and generators. The mining areas are also expected to have increased activity due to hosting project workers. Demand for cooking could be met by biomass resource and LPG.
Mining activities	<p>Limestone and ore mining in various parts of the county will increase demand for energy sources like grid electricity, petrol and diesel for machinery.</p>

Energy Demand Projections

Like many other parts of the country, the energy demand for Kitui County will change depending on such parameters as the prevailing socioeconomic factor, including, population, economic development, industrialization, urbanization, and technological development. Economic development has in the recent past been the main driver of increased energy consumption. The other factors that will be influential in the energy trend are liberalization, energy efficiency improvements, structural changes in industry and level of literacy among other factors.

The growth rate-based method is applied in this survey to forecast the energy demand for Kitui County in the next five years considering per annum economic growth rate and through 40 years projection considering an average homogeneous economic growth rate. Using this model a consideration is made that the energy consumption trend will be hugely dependent on the population growth and the economic growth. The economic growth as of 2016 was 5.84% while that of 2017 was 5.50% showing a decline due to the impact of the political uncertainties which engulfed the country as a result of the prolonged political activities. The 2016 percentage was chosen for this projection because the 2017 growth rate would be deceptive as it was as a result of the transient political season.

2017-2022 Energy consumption projection

Using the Kenya's Growth rate of the real gross domestic product (GDP) from 2012 to 2022 shown in figure 29, the annual projections of 2017 to 2022 are shown in table 8:

Table 8 Statistical figures for Kitui County 5-year energy projection

	2016	2017	2018	2019	2020	2021	2022
Solar (MWh)	41.53	43.10814	44.73763	62.87874	65.48192	68.29109	71.22078
Wind (MWh)	0.6489	0.673558	0.699019	0.982471	1.023145	1.067038	1.112814
Electricity (MWh)	32.315	33.54297	34.81089	48.92671	50.95228	53.13813	55.41776
Biomass (MWh)	1.038	1.077444	1.118171	1.57159	1.636654	1.706866	1.780091
Kerosene (MWh)	61.91	64.26258	66.69171	93.73519	97.61583	101.8035	106.1709
Charcoal (MWh)	47.11	48.90018	50.74861	71.32717	74.28011	77.46673	80.79005
LPG (MWh)	28.94	30.03972	31.17522	43.81677	45.63079	47.58835	49.62989
Total energy consumption (MWh)	213.4919	221.6046	229.9812	323.2386	336.6207	351.0617	366.1223

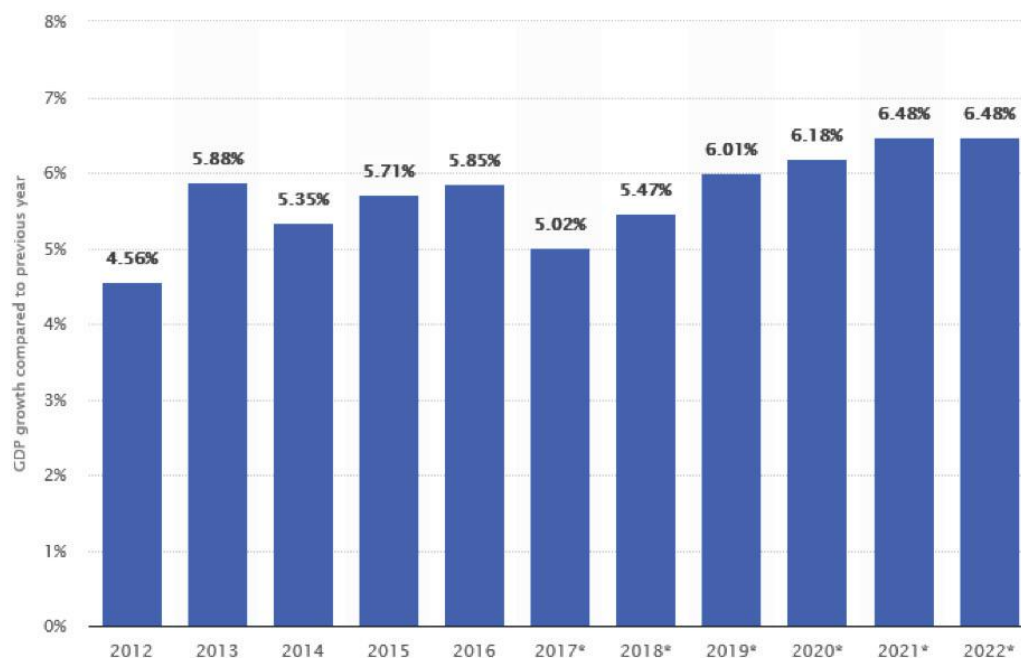


Figure 30 Kenya rate of the real gross domestic product (GDP) from 2012 to 2022

Long term projection 2017-2057

The following assumptions have been made to come up with the 40 year energy projection

1. The trend improvement in known technologies, along with a view of economic and demographic trends reflecting the current central views of leading economic forecasters and demographers.
2. The economic growth rate of 5.84% is homogeneous through all the counties and will remain constant throughout the projection period
3. The population growth rate for Kitui County which stands at 2.10%, and which is 0.50% less than the national population growth which stands at 2.60% will remain constant throughout the projection period.
4. That the current laws and regulations affecting the energy sector both at the national and the county level will remain unchanged throughout the projection period.
5. The potential impacts of proposed legislation, regulations, or standards will be insignificant

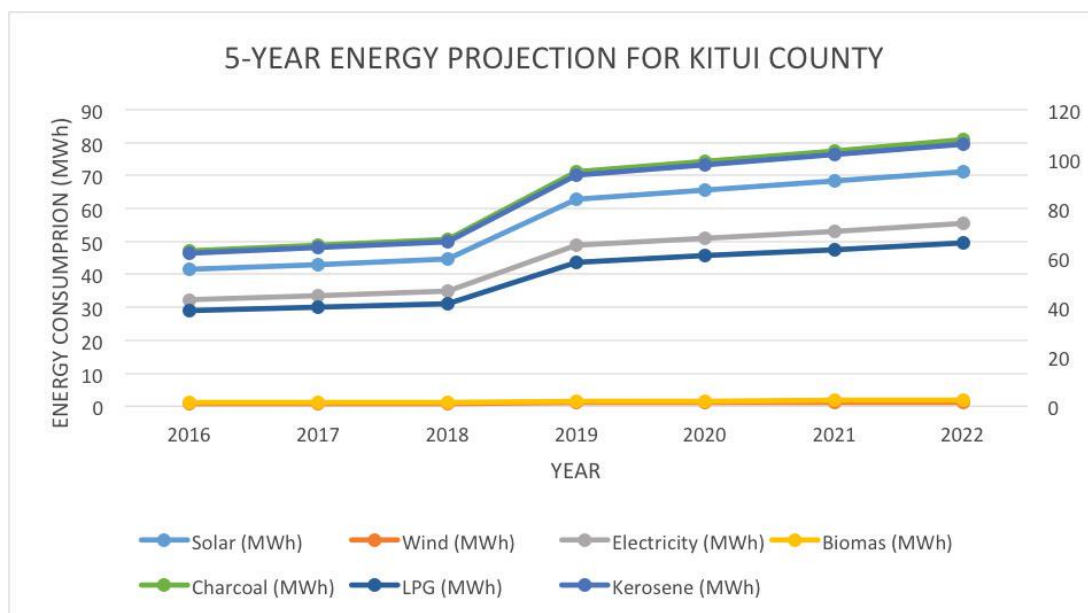


Figure 31 5-year energy projection for Kitui County

Table 9 : Long term projection of energy consumption for Kitui County

	2017	2022	2027	2032
Solar (MWh)	41.53	50.45476073	61.29744	74.47021
Wind (MWh)	0.6489	0.788348043	0.957763	1.163586
Electricity (MWh)	32.315	39.25946528	47.69629	57.94618
Biomass (MWh)	1.038	1.261065293	1.532067	1.861307
Kerosene (MWh)	61.91	75.21440493	91.37791	111.0149
Charcoal (MWh)	47.11	57.23389786	69.53341	84.47608
LPG (MWh)	28.94	35.15918073	42.71486	51.89424
Total energy consumption (MWh)	213.4919	259.3711229	315.1098	382.8266

	2037	2042	2047	2052	2057
Solar (MWh)	90.4738	109.9165	133.5375	162.2346	197.0987
Wind (MWh)	1.413639	1.717429	2.086503	2.534891	3.079637
Electricity (MWh)	70.39876	85.5274	103.9072	126.2367	153.3649
Biomass (MWh)	2.2613	2.747252	3.337634	4.054888	4.92628
Kerosene (MWh)	134.872	163.8558	199.0683	241.8479	293.8208
Charcoal (MWh)	102.6299	124.685	151.4797	184.0325	223.581
LPG (MWh)	63.04627	76.59486	93.05503	113.0525	137.3474
Total energy consumption (MWh)	465.0957	565.0443	686.4718	833.994	1013.219

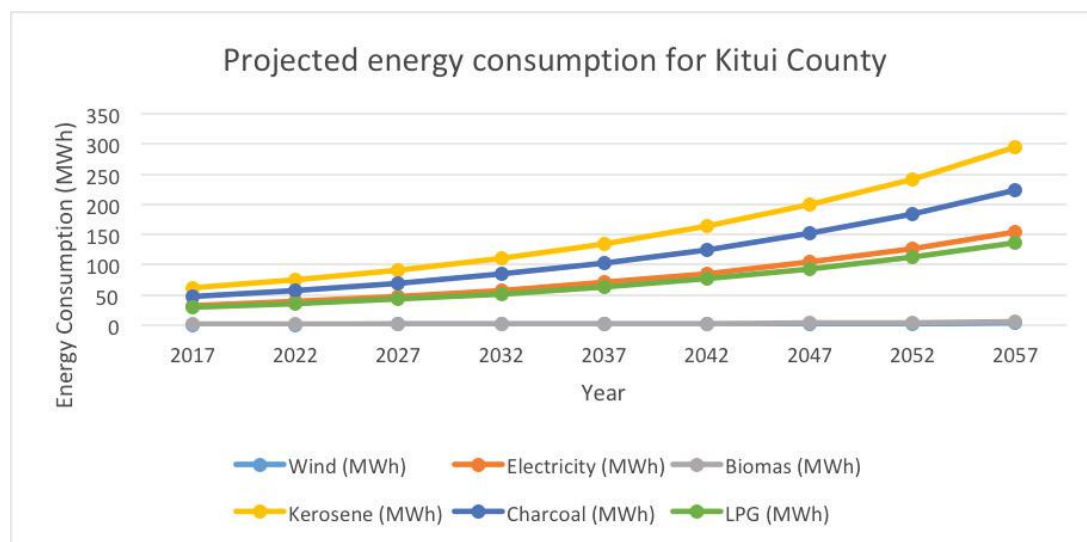


Figure 32: 40-year projection of Kitui County energy consumption

The projected increase in electrification will be accelerated by the current robust investment on rural electrification by both the Rural Electrification Authority (REA) and Kenya Electricity Transmission Company Limited (KETRACO) in the county and if the heavy infrastructural investment results in to an equivalent connectivity then the current one fifth electrification may rise to three quarter by 2057.

In terms of energy equity, the consumption of energy is likely to be fairly balanced as the charcoal producing areas in the county will begin to shift to more modern energy forms for both cooking and lighting. This is likely to lead to traditional and inefficient biomass being phased out by 2037 and establishment of community mini grids that harness solar power, geothermal power and wind power.

Rise in education and awareness will also lead to many more rural households adopting renewable energy as they will have understood their long-term economic sense. Moreover, technological development will also accelerate the adoption of the renewable. Should this be the case then the county is likely to save billions of US dollars a year through energy efficiency and reduced fuel costs. In addition, the county will be able to save from the costs associated with climate change, the added value of the millions of jobs created or health and social benefits like better air quality and well-being. However, for this projected growth to happen there will have to be some rethinking on the current financing for renewable energy. Although the Oil and Gas Resource and Technology cases affect the production of energy, the impact on domestic energy consumption is less significant.

Energy conservation.

While energy projection may indicate sharp rise resulting from industrialization, population increase and economic growth, other factors such as technological advancement are likely to reduce the demand for energy as much more energy efficient systems will be adopted by the county. Individuals, businesses and communities may begin to reduce demand by improving energy efficiency through legally binding minimum efficiency standards and criteria and reducing wasteful use of energy. These energy conservation approaches would result in a significant reduction in demand by 2052.

MAED model evaluates future energy demand based on medium- to long-term scenarios of socio-economic, technological and demographic developments. The model relates systematically the specific energy demand for producing various goods and services identified in the model, to the corresponding social, economic and technological factors that affect this demand. Energy demand is disaggregated into a large number of end-use categories; each one corresponding to a given service or to the production of a certain good. The nature and level of the demand for goods and services are a function of several determining factors, including population growth, number of inhabitants per dwelling, number of electrical appliances used in households, peoples' mobility and preferences for transportation modes, national priorities for the development of certain industries or economic sectors, the evolution of the efficiency of certain types of equipment, market penetration of new technologies or energy forms etc.

Shaping Energy development

Since energy is meant to be a spur not a hindrance to the county development ambitions, energy developments and transitions have a special focus as it has potential not only to transform Kitui alone but impact on other counties as well. Energy developments will be characterized by technology transfer; innovative financing and investments and environmental protection.

More emphasis will focus on:

Financing energy projects: To finance energy projects, County Government will source funds from development partners or financial institutions in form of grants or loans. Article 212 of the Constitution of Kenya prescribes how a County Government may borrow to fund its budget. The county budgeting will also reflect the policy on ensuring at least 30% of the total expenditure goes to development.

Consumer financing through formal and informal institutions will further be enhanced and strengthened.

Quality control for renewable energy products like solar: While the county access to solar products is on a positive trend; concerns over consumers accessing good quality products still remains. More sensitization on consumer education will be carried out. Liaison with Kenya Bureau of Standards and ERC. More solar technicians will be trained in addition to cataloguing of quality products.

Strengthening capacity building elements: Through exchange programme and hands on training, the county will liaise with partners to increase the capacity of personnel on different energy technologies

Promotion of energy efficiency practices: households, institutions and commercial enterprises have the opportunity of adopting energy efficiency measures. Sensitization will be carried out in all the households. This will ensure energy conservation and eventual environmental preservation.

Feasibility studies and more research: To further develop the wind sector; wind campaigns at different heights will be conducted in promising sites with an aim of making good investment decisions for sector investment. Feasibility studies for promising investment will also be conducted for attracting investors.

Cleaner fuels and productive use of energy: Productive use of energy is an indicator for measuring energy access Tier. Households will be sensitized and encouraged to engage in productive use of energy. Transition to cleaner burning fuels at domestic and institution level is anticipated to have huge impacts and contribute to healthier lives and reduced indoor air pollution.

Climate and environmental related information and GHG management. While the current emissions from Kitui energy and other sectors may be minimal, the county will set a framework for documenting mitigation and adaptation energy related activities with an aim of utilizing the same in pursuing financing like Green Climate Fund or Adaptation fund.

Forging partnerships: The fourth schedule of the Constitution of Kenya (2010), entails local communities' involvement and participation for energy sector projects. This gives Counties, including Kitui, big opportunities to tag on the MTP III and develop, in partnership with the national Government, sustainable energy programmes both locally and internationally.



KITUI COUNTY ENERGY OUTLOOK

FINAL REPORT: DECEMBER, 2017