Energy Sector Baseline Study

in the Kakuma-Kalobeyei Refugee-Hosting Area in Kenya

MARCH 2022

KKCF
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2121 Pennsylvania Avenue, N.W.
Washington, D.C. 20433
Internet: www.ifc.org

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About the report

This study provides information for businesses in the energy sector to help them assess opportunities for providing or expanding energy services in the Kakuma and Kalobeyei refugee-hosting areas; it also provides insights to inform IFC interventions. The study maps the supply of and demand for energy for lighting, cooking, and productive use among households and businesses and examines the regulatory environment affecting the energy sector.

IN PARTNERSHIP WITH

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The following people worked on the production of the final report: Hilda Kiritu (Ipsos), Elizabeth Omondi (Ipsos), Melissa Baker (Ipsos), Polina Lenkova (IFC), and Romain Galgani (Consultant, World Bank).

Samuel Emase (Director of Energy, Turkana County Government), Marion Kimani (Operations Officer, IFC), Alexander Larionov (Operations Officer, IFC), Chiharu Shirai (Senior Investment Officer, IFC), Susanne Hounsell (Sector Lead Energy, SNV), Mustafa Al-Momani (Technical Energy Advisor, UNHCR), and Kevin Kerigu Mwangi (GIZ, Kenya) reviewed the report and provided feedback.

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Abbreviations

Ah	Ampere hour
CBO	Community-based organization
EPRA	Energy and Petroleum Regulatory Authority
ID	Identity document
IFC	International Finance Corporation
IRC	International Rescue Committee
KES	Kenyan shillings
Kg	Kilogram
KKCF	Kakuma Kalobeyei Challenge Fund
KPLC	Kenya Power and Lighting Company
kW	Kilowatt
kWh	Kilowatt-hour
kWp	Kilowatt peak
kVA	Kilowatt-ampere
LOKADO	Lotus Kenya Action for Development Organization
LPG	Liquefied petroleum gas
MEI	Moving Energy Initiative
NGO	Nongovernmental organization
PIN	Personal identification number
PV	Photovoltaic
SHS	Solar home system
SNV	Stichting Nederlandse Vrijwilligers
UNHCR	United Nations High Commissioner for Refugees
WARMA	Water Resource Management Authority
Wp	Watt peak

Glossary

Big 4 Agenda	A flagship project of the current president that targets four priority areas for Kenya: ensure food security, provide affordable housing, expand manufacturing opportunities, and provide affordable health care to all citizens.
Biogas digester	A device used to produce burnable biogas through the digestion of organic waste from animal dung or crop waste materials by bacteria.
Businesses	Registered and unregistered trading entities making money by manufacturing or selling goods, or providing a service.
Electricity service providers	Electricity from individuals or organizations that locally produce electric power for sale.
Household	A unit of people living in the same housing unit who eat from the same food pot (have a common cooking arrangement/eat their food together) and are answerable to one household head.
Liquefied petroleum gas	A flammable mixture of petroleum gases (hydrocarbon gases) used as a source of fuel, released during the extraction or refining process of crude oil.
Productive use	The commercial consumption of energy to produce goods or services.
Saving and loan organization	An organization such as a bank, microfinance institution, or savings and credit cooperative organization that allows its customers to save or take credit.
Solar home system (SHS)	Small-scale, stand-alone photovoltaic systems that supply power for lighting and appliances.
Solar lantern	A small portable device that converts energy from the sun into electric power that can be used for lighting or charging phones and other appliances.

Executive summary

Introduction

Refugees are not just people with needs: they are also entrepreneurs, consumers, employers, and employees, despite their circumstances.

Kakuma as a Marketplace, a 2018 consumer and market study of Kakuma refugee camp in northwest Kenya, estimates that Kakuma camp and its hosting community have 2,100 refugee-owned businesses and are worth $56 million based on household consumption.

Private sector investment in local economies has the potential to enhance refugees' self-reliance and their integration with host communities. While such investment is by no means a cure-all, it can be central to creating long-term solutions by reducing poverty and strengthening the economic circumstances of refugee and host communities alike.

This realization prompted the International Finance Corporation (IFC) to engage with private sector actors to discuss business opportunities and barriers in Kakuma camp. Through the Kakuma Kalobeyei Challenge Fund (KKCF), IFC intends to support private sector investments in the Kakuma-Kalobeyei area to improve local people's access to energy services and solutions.

This study provides information for businesses in the energy sector to help them assess opportunities for providing or expanding energy services in the Kakuma and Kalobeyei areas; it also provides insights to inform IFC interventions. The study maps the supply of and demand for energy for lighting, cooking, and productive use among households and businesses in the camp and examines the regulatory environment affecting the energy sector.

1. Characteristics of the Kakuma-Kalobeyei Area

The regions focused on in this study include Kakuma town, Kakuma refugee camp, Kalobeyei town, and the Kalobeyei settlement villages. Kakuma camp and the Kalobeyei settlement villages are located in Turkana County in Kenya. According to the United Nations High Commissioner for Refugees (UNHCR), in May 2021 these settlements had a population of 211,337 registered refugees and asylum-seekers.

The area is home to refugees from South Sudan, Somalia, the Democratic Republic of Congo, Burundi, Ethiopia, Uganda, and Rwanda, among other countries in the region. The population has grown over the years and, as a result, Kakuma has expanded from one to four camps.

To accommodate the growing population, the Kalobeyei refugee settlement was created in 2016, just 3.5 kilometers from the Kakuma camps and 15 kilometers along the highway from Kakuma town. Unlike the earlier approach taken with the refugee camps, Kalobeyei settlement was created with the aim of allowing refugees to become as self-reliant as possible. Three Kalobeyei villages were established.

94%

Households that possess a mobile phone

Households

Access to energy is a challenge for refugees and host communities in the region. One constraint for people in these communities is their low level of disposable income. As part of this study, a survey measured average monthly household income at 10,000 Kenyan shillings (KES) ($93), although people are wealthier in Kakuma town, where the household income was measured at 2.6 times that of the other areas.

Only half of households earn a consistent monthly income, with self-employment in small businesses being the most common form of employment. A minority of households (15 percent), predominantly in the refugee areas, depend on grants from nongovernmental organizations (NGOs) or donor agencies. Fifty-five percent of households reported that their income has decreased due to the COVID-19 pandemic.

The majority of the population comprises young people aged between 18 and 35 years. In the household survey, almost 75 percent of the sample were from this age group. Educational attainment is generally low, with 64 percent of respondents reporting either primary education or no education. Ownership of electronic devices, with the exception of mobile phones, is generally low across the study locations.

About 94 percent of households possess a mobile phone, with an average of two mobile phones per household. This presents an opportunity for donors and partners to update households living in these areas on job and other opportunities through bulk SMS messaging. However, only about half of the surveyed respondents report that they are able to read in English or Swahili, with the percentage being particularly low in Kalobeyei town (34 percent).

Businesses

Most of the businesses in the study locations are small shops and grocery stores. The majority of businesses in Kakuma refugee camp and Kalobeyei settlement are owned by men (74 percent and 72 percent respectively). The situation is different in the host community, where 83 percent of businesses in Kakuma town and 69 percent in Kalobeyei town are owned by women.

Business owners are better educated than the general population and average net monthly income from their business is about 15,344 Kenyan shillings ($142), with businesses in Kakuma camp making slightly more than the average. A large majority of business owners reported that their income had declined due to the COVID-19 pandemic. Ownership of electric appliances is in line with the findings for households, albeit with a higher rate of ownership of refrigerators and security lights.

2. Lighting

Solar lanterns are the most commonly used source of energy for lighting in households, with 29 percent of households using them as a primary source of lighting. This is followed by solar home systems (SHSs) at 16 percent, dry-cell torches (13 percent), mobile phones with a built-in torch function (11 percent), and private electricity service providers (11 percent). About 8 percent of households in the study areas reported that they have no means of lighting at night; this was especially the case in Kalobeyei settlement (21 percent) .

Table 1: Summary of results for lighting – households

	Solar lantern	SHS	Electricity from private electricity service providers	KPLC connection
Percentage that use energy source	34%	18%	13%	5%
Percentage that use as primary energy source	29%	16%	11%	3%
Percentage that purchase energy source (as opposed to getting it for free)	42%	90%	-	-
Average purchase price (KES)	1,662	28,264	1,058 per month	600 per month[1]
Greatest consumer challenge	Poor performance in bad weather (48%)	-	Unreliable supply (75%)	Unreliable (28%)
Would be interested to pay market price – given the opportunity (% of non-owners/ unconnected)	76%	58%	81%	
Most cited reason for willingness to pay	Lighting for children's homework (62%)	Lighting for children's homework (52%)	Lighting for children's homework (60%)	
Completely sure they would pay market price for it (% of non-owners/unconnected)	64% (at KES3,174 / $29)	59% (at KES10,000 / $93)	76% (at KES600 / $5.50 per month)	
Would definitely be interested to pay market price – given the opportunity (% of all households surveyed)	20% (at KES3,174 / $29)	20% (at KES10,000 / $93)	58% (at KES600 / $5.50 per month)	
Estimated yearly sales and income (from supplier mapping)	3,588 units, KES9,345,000 ($85,133)	2,400 units, KES32 million ($315,000)	-	-

1 A number of these had recently been connected to electricity by Kenya Power and the amount consumed per month may change over time with their potential acquisition of electronic devices.

Table 2: Summary of results for lighting – businesses

	Solar lantern	SHS	Electricity from private electricity service providers	KPLC connection
Percentage that use energy source	24%	30%	26%	9%
Percentage that use as primary energy source	22%	27%	21%	5%
Percentage that purchase energy source (as opposed to getting it for free)	64%	97%	-	-
Average purchase price (KES)	1,278	31,570	2,735 per month	1,296 per month
Greatest consumer challenge	Poor performance in bad weather (51%)	-	Inconsistent supply (47%)	High energy consumption rate (60%)
Would be interested to pay market price – given the opportunity (% of non-owners/ unconnected)	90%	85%	94%	
Most cited reason for willingness to pay	Longer operating hours (68%)	Longer operating hours (75%)	Longer operating hours (53%)	
Completely sure they would pay market price for it (% of non-owners/unconnected)	68% (at KES5,917 / $55)	64% (at KES15,638 / $145)	78% (at KES1,200 / $11)	
Would definitely be interested to pay market price – given the opportunity (% of all businesses surveyed)	28% (at KES5,917 / $55)	26% (at KES15,638 / $145)	65% (at KES1,200 / $11)	

22%

Business respondents use solar lanterns as their primary lighting source

Solar Lanterns – Households

About 29 percent of households use solar lanterns as a primary source of lighting, with an average of one solar lantern per household. On average, households have been using solar lanterns for the last 2.1 years. Those that purchased their solar lanterns bought them at an average price of KES1,700 ($16). The main challenges that households face include the output being affected by bad weather, especially during the rainy season (48 percent), and affordability (18 percent).

Solar Lanterns – Businesses

Only 22 percent of business respondents use solar lanterns as their primary lighting source, and use is highest in Kakuma town (33 percent). They have used their solar lanterns for about 1.3 years on average. The average amount of money spent to purchase a solar lantern is about KES1,278 ($11.90).

Solar Lanterns – Trade

Most of the traders selling solar lanterns are in Kakuma town, selling a combined 300 solar lanterns a month. The main traders sell lanterns worth about KES778,750 ($7,094) per month (sales from all traders combined), which translates to KES9,345,000 ($85,133) in overall sales per year. The average price that households are willing to pay for a solar lantern is KES3,174 ($29). Since price is the main barrier to greater uptake of lanterns, providers should be encouraged to offer credit payment models or a staggered upfront payment approach.

16%

Solar Home Systems

A total of 16 percent use SHSs as a primary source to meet their lighting needs. This is most prevalent in Kakuma town (27 percent) and Kakuma camp (17 percent). Households tend to have an SHS with an average capacity of 100 watts, supported by a battery size of around 80 Ah. The average cost of acquiring this SHS is about KES28,264 ($255) – this involves purchasing the equipment and setting it up. To fund the acquisition, 79 percent use their own earnings and pay in cash up front. Households that did not yet own an SHS cited affordability as the main challenge. For SHS distributors, it is a challenge to find local technicians to do the installation and maintenance.

11%

Electricity Supplied by Private Electricity Service Providers

Eleven percent of households use power supplied by private electricity service providers as their primary source of lighting. Most households have been using this power source for four years on average. This is mostly the case in Kakuma camp, where unregulated private providers operate. Households spend an average of KES1,058 ($10) per month on power bills, except for households in Kalobeyei settlement that benefit from Renewvia's mini-grid and pay around KES400 ($3.60) a month. Households in Kakuma camp are mostly charged a fixed monthly rate, while those in Kalobeyei settlement are charged a rate based on consumption. Most household respondents cited the inconsistent power supply from the private electricity service providers in Kakuma camp as a challenge. This energy source is also deemed to be too expensive by 16 percent of households in Kakuma camp using it.

8%

Electricity from Kenya Power and Lighting Company

Only 8 percent of households in Kakuma town use electricity from KPLC as the primary source of lighting. Households spend about KES600 ($5.50) on power per month. The main challenge households face is the high connection fee (KES15,000 or $137). KPLC electricity is currently not available outside Kakuma town.

<1%

Generators

Only seven households out of the total sample reported using generators, which translates to less than 1 percent ownership. There is also a low uptake of generators among businesses, with only 5 percent of business respondents reporting having them. Challenges cited by owners of generators include unavailable genuine spare parts, inadequate supply of diesel in the study areas, and lack of qualified technicians to do repairs.

3. Commercial Consumers' Energy Demand for Lighting

About 27 percent of the businesses interviewed use SHSs (locally referred to as solar panels) as their primary lighting source. This is followed by solar lanterns (22 percent) and electricity generated by private electricity service providers (21 percent). About 10 percent of businesses have no source of lighting, which limits their ability to operate after dark.

27%

Solar Home Systems

About 27 percent of the businesses interviewed use SHSs as their main source of lighting – this is a higher proportion of use than that observed in the households. More businesses in Kakuma camp (31 percent), Kalobeyei town (28 percent), and Kakuma town (25 percent) use SHSs as their primary lighting source compared to businesses in Kalobeyei settlement (11 percent). Businesses tend to have SHSs with an average capacity of 160 watts, supported by a battery size of 100 Ah. This is a higher capacity than that commonly found in the households. The average cost of the SHS is about KES31,570 ($292). The main barrier to purchasing an SHS is the high initial cost, which suggests that a credit purchase model or staggered upfront payment model may work better.

21%

Electricity Supplied by Private Electricity Service Providers

About 21 percent of the interviewed businesses rely on private electricity service providers as a primary source to meet their lighting needs. These businesses have been using this power for about three years on average. In Kakuma camp, where unregulated producers are prevalent, businesses pay a flat monthly fee. On average, these businesses spend around KES2,568 ($24) per month on electricity.

The same challenges faced by households apply to businesses. In Kakuma camp, these include inconsistent power supply, technical/mechanical issues that disrupt power supply and take a long time to resolve, short operational time, the high cost of power, and poor customer service. About half of business respondents in Kalobeyei who are using an electricity service provider (predominantly solar-power mini-grids) also reported experiencing blackouts on rainy days when there is low sunlight absorption.

17%

Electricity from Kenya Power and Lighting Company

Seventeen percent of the interviewed businesses in Kakuma town use power supplied by KPLC as their primary lighting energy source, with power currently unavailable in other locations. Most of these businesses have been connected for two years on average. They pay about KES1,125 ($10) per month for this energy source.

7

Generators

Only seven businesses use a generator: four of the generators are used by refugee businesses while three are used by host community businesses. Six of the generators are solely used by the business, while one is co-used with 13 other businesses.

4. Household Energy Demand for Cooking

Table 3: Summary of results for cooking – households

	Firewood	Charcoal	LPG
Percent of households that use energy source	78%	59%	4%
Main source	Provided for free by UNHCR/NGOs (73%)	Purchased (96%)	Purchased (95%)
Average purchase price (KES)	264 per week	288 per week	1,368 for 3 kg cylinder refill, 1,432 for 6 kg cylinder refill
Greatest consumer challenge	Expensive (37%)	Expensive (75%)	Expensive (58%)
Would be interested to pay market price – given the opportunity (% of non-users)	-	-	66%
Most cited reason for willingness to pay	-	-	Quick cooking (70%)
Completely sure they would pay market price for it (% of non-users)	-	-	65% (at KES2,500 / $22.70)
Would definitely be interested to pay market price – given the opportunity (% of all households surveyed)	-	-	25% (at KES2,500 / $22.70)
Estimated yearly sales and income (from supplier mapping)	7,080 large bundles, KES5,136,000 ($46,800)	12,468 bags, KES8,491,200 ($77,354)	3,456 units, KES5,160,000 ($47,007) per year

96%

of households using charcoal, purchase it

In Kakuma and Kalobeyei, firewood and charcoal are the main sources of energy for cooking. About 78 percent of households reported using firewood for cooking. The dependence on firewood appears to be particularly high among refugee households. On the other hand, around 59 percent of households use charcoal for cooking, with the percentage higher in Kakuma town (79 percent). There is low penetration of liquefied petroleum gas (LPG) across all locations.

Below is a supply-side analysis for the major sources of energy for cooking.

$10pm

Firewood

Host community members mainly collect their own firewood, while the vast majority of refugees obtain it from UNHCR. Given that the UNHCR ration is not enough to meet household needs, refugees also collect and buy firewood.

Households in Kakuma and Kalobeyei spend on average about KES1,054 ($10) per month on firewood. Firewood collection is often done by female adults in the households (84 percent), assisted by children (female children – 13 percent, male children – 8 percent). Only 12 percent of males in households collect firewood. Firewood collection often exposes women, especially refugees, to gender-based violence.

59%

Charcoal

About 59 percent of households use charcoal for cooking, particularly in Kakuma town (79 percent). About 96 percent of all households purchase their charcoal.

The average monthly expenditure per household on charcoal is KES1,150 ($10). This is often purchased from a local trader. As for challenges, three-quarters of households using charcoal say that the price is too high.

50%

Liquefied Petroleum Gas

Fifteen percent of households in Kakuma town and 4 percent of households in Kalobeyei town use LPG for cooking. Half have the 6 kilogram cylinder, 30 percent own a 3 kilogram cylinder, 11 percent have a 13 kilogram cylinder, and the rest own a different type (5 kilogram, 7.7 kilogram, or 8 kilogram).

Seven out of every 10 LPG users used their earnings at the time to meet the initial cost of buying a cooker and gas cylinder. Refilling a 6 kilogram cylinder costs an average of KES1,400 ($13), while a 13 kilogram cylinder costs KES3,000 ($27). The high initial purchase cost of an LPG cylinder was mentioned as a key challenge by the majority of respondents (58 percent).

11%

Among businesses interviewed do not even have access to energy for lighting

5. Energy for Productive Use

Businesses use SHSs, private electricity service providers, and electricity from KPLC for lighting and to power electrical equipment. Among businesses that own power-intensive appliances such as televisions, refrigerators, and security lights, the use of the three energy sources is significantly higher: 54 percent use SHSs (compared to 16 percent for those without power-intensive appliances), 32 percent use private electricity service providers (compared to 18 percent), and 6 percent use KPLC electricity (compared to 2 percent).

Firewood and charcoal, which are exclusively used for catering purposes, are the main energy sources for cooking: 57 percent of catering businesses use charcoal for cooking, while 21 percent use firewood. Businesses with access to energy earn, on average, 2.9 times more than businesses without a source of energy. Among the businesses interviewed, almost a third do not use energy for productive use, while 11 percent do not even have access to energy for lighting.

6. Energy Solutions Supply and Market Size

$24,529pm

Solar Home Systems

Currently, suppliers of SHSs together make KES2,692,500 ($24,529) in a good month. Demand for SHSs is not consistent month to month, although smaller-capacity products tend to be purchased most often. The usual capacity of SHSs sold is 60 watts, which is priced at KES9,000 ($82) – or KES12,000 ($109) including installation.

Some traders sell an 80-watt panel, which is preferred by businesses, priced at KES19,500 – KES22,000 ($178 – $200) for the whole SHS power system, with the higher priced ones including the cost of installation. Given that grid power has a higher preference score, potential demand for SHSs would be affected by the availability of affordable and consistent grid power.

23

Electricity Supplied by Private Electricity Service Providers

Twenty-three providers of this power source in the study location were identified and interviewed. There are about 1,588 power connections in Kakuma, which generate an overall revenue of about KES2,352,500 ($21,431) per month. In a year, this translates to KES28,230,000 ($257,174).

Most of these power providers charge a fixed rate that varies depending on the consumer category (household vs business) and is based on the number of electrical appliances that need to be powered. The main challenge that private electricity service providers face is a lack of locally skilled technicians to provide repair and maintenance services.

$137

Electricity from Kenya Power and Lighting Company

KPLC has an electricity station powered by two generators in Kakuma. To get connected, a customer is required to pay a connection fee of KES15,000 ($137). Given that a national identification document is required to connect, refugees face challenges in accessing this power source.

The same application requirements apply to businesses, which are also required to attach copies of their business registration certificate and personal identification number (for tax purposes). Given the predominantly informal business environment in Kakuma and Kalobeyei, businesses face challenges in meeting such requirements.

$47k

Average sales of gas refills per year

42

Firewood

The research team identified 42 large-scale firewood suppliers in the study locations, which also sell firewood to smaller-scale resellers. Traders are mostly members of the host community, selling firewood that they collect to refugees.

The livelihoods of these traders, as well as the other small-scale traders who purchase from them, would be affected if alternative cooking fuels were adopted by consumers in Kakuma and Kalobeyei. Firewood traders sell firewood worth KES5,137,116 ($46,798) annually (57 percent in Kakuma camp, 38 percent in Kalobeyei settlement, 6 percent in Kakuma town, and 1 percent in Kalobeyei town).

$6,446pm

Charcoal

Traders sell charcoal valued at KES707,600 ($6,446) monthly, which translates to KES8,491,200 ($77,355) per year. The revenue split among locations is 40 percent in Kakuma town, 37 percent in Kalobeyei settlement, 22 percent in Kakuma camp, and less than 1 percent in Kalobeyei town.

High transportation costs drive up the price of charcoal for traders. Even with the price increases, the traders struggle to meet demand due to the destruction of forest reserves; as such, energy-saving charcoal cookstoves would be advantageous.

$27–$30

LPG

In the study areas, only four traders distributing LPG cylinders and cookers were identified, all of whom are based in Kakuma town. The refills sell for between KES1,200 ($11) and KES1,500 ($14) for the 6 kilogram cylinder. The refill for the 13 kilogram cylinder costs between KES3,000 ($27) and KES3,300 ($30).

On average, the traders/suppliers make KES430,000 ($3,917) a month selling gas refills, which translates to an average of KES5,160,000 ($47,007) per year. Three-kilogram cylinders were not reviewed in this study but may represent a more affordable option for households.

1

Generators

In the study areas, only one trader of generators was found. This trader is based in Kakuma town and sells about four generators in a good month. Uptake is rather low because of the high price. Installation requires an experienced technician, who is also not readily available. Inconsistent supply of diesel and petrol is also a challenge.

$137

Average monthly net income made by businesses

7. Energy Preferences and Economic Realities

Sources of Energy that Households Prefer

Electric power, whether obtained from KPLC or private mini-grids, is the most preferred source of energy for lighting; 81 percent of respondents without access to it declared being willing to be connected. This is followed in preference by SHSs (72 percent) and solar lanterns (64 percent). In terms of energy for cooking, LPG has the highest preference score, with 61 percent of households without LPG having considered acquiring it.

Sources of Energy that Businesses Prefer

Grid-quality electric power (from KPLC or private producers) has the highest preference score (94 percent), followed by SHSs (66 percent) and solar lanterns (58 percent).

Households' Ability to Pay

An average household spends about KES1,600 ($15) in total on all energy solutions per month. This translates to 16 percent of the average monthly household income of KES10,000 ($93). This is important to keep in mind when designing energy solutions and payment plans, as these households need credit products and solutions that can accommodate their erratic cash flows.

Nevertheless, the households have unmet energy needs. Most households have a number of electrical appliances that require power, and extending the coverage of electric power could help these households meet their various needs.

Businesses' Ability to Pay

Businesses spend an average of KES2,500 ($23) per month on energy. As they make an average monthly net income of about KES15,000 ($137), this means that they spend about 19 percent of their income on meeting their energy needs.

Extending the coverage of electric power (whether through KPLC or private mini-grids) could help these businesses meet their needs. Indeed, business respondents mentioned that accessing electric power would help them extend their operating hours (53 percent) or start another income-generating activity on the premises (29 percent).

8. Impact of COVID-19 on Households

Since the outbreak of the COVID-19 pandemic, energy expenditure has stayed the same for lighting for 42 percent of households, while 28 percent reported an increase in their energy expenditure. However, there was a slight increase in energy consumption for cooking for 37 percent of households, with consumption staying the same for 34 percent. Willingness to pay for energy products has decreased for a third of households.

9. Impact of COVID-19 on Businesses

Eighty-seven percent of businesses reported that their income had decreased as a result of the pandemic. Energy expenditure on lighting stayed the same for 46 percent of business respondents, while willingness to pay for energy products decreased for a third of businesses.

Source: www.pexels.com

10. Potential Solutions and Business Models

Technical solutions and business models that can be implemented to improve access to clean energy solutions are outlined in Table 4.

Table 4: Potential technical solutions and business models

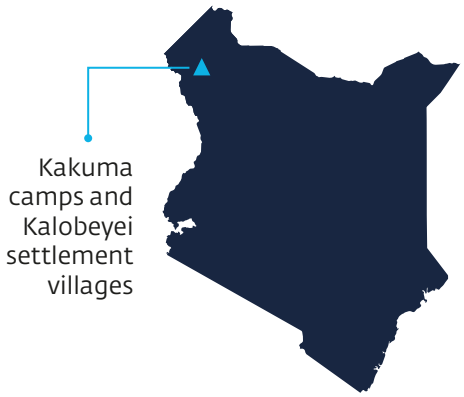
Areas of intervention	Recommendations
Energy for cooking	• Support initiatives that expand the use of energy-saving cookstoves. • Help households and businesses acquire LPG by partnering with one of the large fuel distribution companies to extend the scope of their operations to the Kakuma and Kalobeyei areas. There is also a need to support a credit purchase model where customers can deposit small amounts of money to go toward buying an LPG cylinder and cookers.
Energy for lighting and productive use	• Support the expansion of private electricity service providers through the following measures: — Densify the existing grids. — Establish more renewable energy-powered mini-grids to serve more customers. — Aggregate power across current producers and have one supplier responsible for the distribution. — Introduce a metered power consumption model where households pay a certain rate per kilowatt-hour consumed rather than a flat rate. — Establish partnerships to upgrade technicians' skills. — Establish partnerships with donor organizations pursuing similar initiatives such as GIZ and UNHCR to establish larger-scale mini-grids. — Enhance the efficiency of cash transfer programs with donor organizations to give beneficiaries the freedom to buy non-food items from a pre-approved list that includes several energy solutions. • Support initiatives seeking to expand the reach of solar lanterns and SHSs. There is significant demand for these energy solutions, as this study shows. However, potential customers lack sufficient savings to acquire SHSs and struggle with access to credit, mainly because their income is unstable. The following proposals are therefore suggested: — Improve quality assurance to encourage durable SHS products and lanterns. — Build a pool of technicians that can install and maintain SHS products. — Create stronger links with financial institutions to support the purchase of SHSs. — Engage with development partners to help subsidize the purchase of SHSs in the study areas.

1. Introduction

01

The Kakuma camps and Kalobeyei settlement villages are located in Turkana County in Kenya. According to UNHCR, in May 2021 these settlements had a population of 211,337 registered refugees and asylum-seekers.

Figure 1: Kakuma and Kalobeyei settlement location in Kenya



Source: Designed by the Ipsos team

The area is home to refugees from South Sudan, Somalia, the Democratic Republic of Congo, Burundi, Ethiopia, Uganda, and Rwanda,[2] among other countries in the region.

Over the years, Kakuma has grown from one to four camps as the population increased. To accommodate this growing population, in 2016 the Kalobeyei refugee settlement was created, just 3.5 kilometers from the Kakuma camps and 15 kilometers from Kakuma town.[3] Unlike the approach taken with earlier refugee camps, Kalobeyei settlement was created with the aim of allowing refugees to become as self-reliant as possible.[4] Three Kalobeyei villages have been established.

The refugee camps and villages are managed by UNHCR, in close collaboration with the Refugee Affairs Secretariat. They are supported by implementing partners such as the Norwegian Refugee Council, which is responsible for water, sanitation, and hygiene, and the International Rescue Committee, which is responsible for health care.

To boost economic growth, additional investments are needed in three interconnected sectors: road connectivity, energy, and water.[5] More public and private sector investment is also needed in economic and social facilities to support sustainable growth.[6]

2 Energy4Impact, Moving Energy Initiative brings clean energy and improves livelihoods for Kakuma refugees, https://www.energy4impact.org/news/moving-energy-initiative-brings-clean-energy-and-improves-livelihoods-kakuma-refugees

3 Alexander Betts, Naohiko Omata, Olivier Sterck, "The Kalobeyei Settlement: A Self-Reliance Model for Refugees?", https://academic.oup.com/jrs/article-abstract/33/1/189/5819360?redirectedFrom=fulltext

4 Ibid.

5 KISEDP, Kalobeyei Integrated Socio-Economic Development Plan in Turkana West, https://www.unhcr.org/ke/wp-content/uploads/sites/2/2018/12/KISEDP_Kalobeyei-Integrated-Socio-Econ-Dev-Programme.pdf

6 Ibid.

People living in remote or poor areas do not have access to reliable energy sources

Kakuma and Kalobeyei form a significant market

Refugees are not just people with needs: they are also entrepreneurs, consumers, employers, and employees, despite their circumstances. Indeed, the 2018 report *Kakuma as a Marketplace* estimates that Kakuma camp and its hosting community have 2,100 refugee-owned businesses and are worth $56 million based on household consumption. This report reveals that there is potential to enhance refugees' self-reliance and integration with host communities through private sector engagement. Private sector investment is important for improving local economies as it helps increase self-reliance and reduce poverty.[7] Although such investment is by no means a cure-all, it can be a central part of creating long-term solutions.

This realization prompted IFC to engage with private sector actors to discuss business opportunities and barriers in the camp. Through KKCF, IFC intends to support private sector investments in the Kakuma-Kalobeyei area. KKCF is a five-year program of IFC, implemented in collaboration with the Africa Enterprise Challenge Fund, the Turkana County Government, and UNHCR. It is designed to support private sector investment and unlock the economic potential of refugees and their hosts. The program consists of three components:

- A rolling competitive business challenge to incentivize commercial companies, social enterprises, and local entrepreneurs to start or expand viable and sustainable businesses in the refugee camp and host communities.
- An investment climate and policy advisory intervention to work with the Turkana County Government on the creation of a conducive business environment.
- Hands-on support to larger companies to resolve "doing business" issues such as access to land, water, and electricity, and hiring refugees.

7 UNHCR, Kalobeyei Integrated Socio-Economic Development Plan in Turkana West, https://www.unhcr.org/ke/wp-content/uploads/sites/2/2018/12/KISEDP_Kalobeyei-Integrated-Socio-Econ-Dev-Programme.pdf

1.1: Energy access among refugees

Goal 7 of the United Nations' Sustainable Development Goals seeks to ensure access to affordable, reliable, sustainable, and modern energy for all by 2030.[8] A well-established energy system supports all sectors, from medicine and education to agriculture, infrastructure, communications, and high technology.[9] Access to reliable energy is thus essential for the well-being of all people. However, people living in remote or impoverished areas do not have access to reliable sources of energy.

This is the case for host and refugee households in the Kakuma and Kalobeyei areas. A myriad of issues hamper reliable access to energy, including lack of sufficient power-generation capacity, poor transmission and distribution infrastructure, the high cost of supplying remote areas, and the lack of affordable electricity.[10] For off-grid electrification, including mini-grids, the biggest challenges are poor policies, inadequate regulations, lack of planning and institutional support, lack of financing for off-grid entrepreneurs, and affordability for poorer households.[11]

KKCF provides an opportunity to address some of these issues and enhance energy access for communities living in Kakuma and Kalobeyei.

8 SDG Compass, SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all, https://sdgcompass.org/sdgs/sdg-7/
9 Ibid.
10 The World Bank, Access to Energy is at the Heart of Development, https://www.worldbank.org/en/news/feature/2018/04/18/access-energy-sustainable-development-goal-7
11 Ibid.

1.2: Study rationale

The study on which this report is based was developed in the context of the sizeable Kakuma market and the fact that energy is an unmet need in the Kakuma area. It aimed to identify opportunities, challenges, and next steps for businesses wanting to become involved or expand their involvement in providing energy in the region.

The study covers mini-grids, solar home systems, solar lanterns, and other products for lighting, cooking, and productive use.

How to use this report

Interested businesses can use this report to understand the nature of the economic opportunity in the Kakuma area, assess the likely return on investment, and identify practical steps to entering the market.

The study underpinning this report aimed to:

- Determine market size and potential by assessing demand in terms of current consumption, expenditure, and ability/willingness to pay, and by segmenting by refugee household, host household, business, and geographic area.
- Provide information on current sources and uses of energy.
- Identify regulatory and other barriers to market entry, and potential mitigatory measures.
- Map supply.
- Outline potential business models, technical solutions, and financing requirements.

1.3: Methodology

The evidence in this report was collected from a desk review of existing data and literature, key informant interviews, and a household and business survey.

The **data and literature review** looked at data from the 2019 Kenya Housing and Population Census, reports from humanitarian and development agencies and NGOs, and laws, regulations, and strategies relating to the energy sector.

Thirteen **interviews** were then conducted with individuals who are knowledgeable about the energy challenges facing the population in the region. This included representatives from UNHCR; SNV; the Energy Regulatory Commission, now known as the Energy and Petroleum Regulatory Authority (EPRA); the Turkana County Government; and energy suppliers in Kakuma and Kalobeyei such as d.light, Renewvia, Sun King, and LOKADO. KPLC was interviewed as part of the KKCF Strategic Environmental and Social Assessment conducted in late 2019. The feedback from KPLC was incorporated into this report.

Surveys were conducted among a sample of 1,051 households and 159 businesses selected using a 200 square meter geospatial grid from which sampling squares were randomly selected. Within selected squares, a random walk methodology was used to select households and a full listing of businesses present was used to randomly select businesses to interview. Data collection took place in October 2020.

The household survey findings can be considered representative for the specific locations under focus (Kakuma town, Kakuma camp, Kalobeyei town, and Kalobeyei settlement). Given that the field team diverged from the sampling plan (resulting in undersampling in Kalobeyei settlement), adjustments were made by weighting the data. The following exchange rate was applied throughout the report: $1 = 109.6 Kenyan shillings (KES). Additional details on the study approach are provided in Appendix 9.1.

02

2. Characteristics of the Kakuma and Kalobeyei populations

This section provides information on the characteristics of the population living in these areas, drawn from the household and business survey data.

2.1: Households

Seventy-two percent of the household respondents were female (88 percent in Kalobeyei town and 67 percent in Kakuma camp). The intention was to target household heads, and in their absence, a person who is most knowledgeable about purchasing decisions. Women were chosen to answer the questionnaire since they were best informed about energy use in the household. Most household heads, as reported by survey respondents, were male.

Across both the refugee camps and the host communities, most respondents (75 percent) were female and between the ages of 18 and 35. The average age of respondents was 30.

Household sizes are large compared with the Kenya national average of 3.9.[12] On average, there are seven people per household (eight per household in Kakuma camp and six in Kalobeyei town). About half of household members are children.

12 KNBS, 2019 Kenya Population and Housing Census results, https://www.knbs.or.ke/?p=5621

Table 5: Gender, average age of respondents, and household size

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	1,001	260	468	63	210
Male respondents	28%	20%	33%	12%	29%
Female respondents	72%	80%	67%	88%	71%
Average age of respondents	30	31	27	30	32
Average number of people in the household	7	7	8	6	7
Average number of children in the household	4	4	5	3	4

Refugees most commonly come from South Sudan (46 percent), followed by Somalia (19 percent) and the Democratic Republic of Congo (13 percent). The distribution of nationalities is more heterogeneous in Kakuma camp than in Kalobeyei settlement, where the majority are from South Sudan.

Table 6: Refugee nationalities

	Total	Kakuma camp	Kalobeyei settlement
South Sudanese	46%	42%	68%
Somali	19%	23%	0%
Congolese	13%	13%	14%
Sudanese	8%	8%	10%
Burundian	7%	7%	6%
Other (Ethiopian, Rwandese, Ugandan)	9%	7%	2%

Around half of respondents can speak English and 73 percent can speak Swahili. Fifty-eight percent claim to be able to complete forms while less than half can read in either Swahili or English. Kakuma town has the largest proportion able to read and write in English or Swahili and fill in forms, while Kalobeyei residents are the most challenged in this regard.

Table 7: Language skills

	Total	Kakuma camp	Kalobeyei settlement	Kakuma town	Kalobeyei town
Ability to speak English	49%	48%	51%	54%	37%
Ability to speak Swahili	73%	72%	71%	81%	57%
Ability to read in English	44%	43%	44%	48%	28%
Ability to read in Swahili	45%	41%	44%	58%	34%
Ability to fill in forms	58%	57%	58%	63%	46%

36%

Had no education at all

Education levels

Just over a third of the heads of household had no formal education, 21 percent had completed some primary education, and 15 percent had completed secondary education or higher. There is no significant difference in educational attainment between refugees and host communities. However, the average level of education in Kalobeyei town is significantly lower than in the other locations, with 55 percent of household heads having no formal education at all.

Table 8: Household head's highest level of education

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	1,001	260	468	63	210
No formal education	36%	32%	37%	55%	32%
Some primary education	21%	23%	18%	10%	29%
Primary education completed	7%	7%	7%	3%	7%
Some secondary education	19%	12%	24%	13%	21%
Secondary education completed	9%	12%	9%	7%	8%
Higher education – college or university	6%	14%	6%	7%	3%
Other	1%	0%	1%	1%	0%

$93

Monthly income across the Kakuma-Kalobeyei area

Dwelling types

Semi-permanent houses are predominant: 47 percent live in houses made of clay or mud, cow dung, and iron sheets, and 34 percent live in temporary buildings made of tent fabric or other material. Only 13 percent live in permanent dwellings made of cement, burnt bricks, or stones.

In Kakuma camp, many refugees live in semi-permanent or temporary buildings (52 percent and 47 percent respectively). This contrasts with Kalobeyei settlement, where 64 percent live in a permanent dwelling made of stone and iron sheets built under the Cash for Shelter program. Dwellings in the refugee areas have been provided by UNHCR (93 percent in Kakuma camp and 96 percent in Kalobeyei settlement). Many of the host community live in semi-permanent houses that they own (53 percent in Kakuma town and 46 percent in Kalobeyei town).

Income status

Across the Kakuma-Kalobeyei area, an average household makes a monthly income of KES10,000 ($93). Half of households earn a consistent monthly income. However, there are significant differences in average income between host communities and refugees.

Residents of Kakuma town earn about KES17,900 ($166) per month, which is three times as much as refugees in Kakuma camp. The income of households in the host communities in Kalobeyei town is not significantly different to the income of refugees in Kalobeyei settlement.

Table 9: Average monthly household income

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	711	225	318	48	120
Average monthly household income (KES)	10,000	17,900	5,700	8,400	7,700

Note: All numbers are rounded to the nearest 100

A quarter of households rely on self-employment or business – for example, small-scale grocery sales and food sales – as their main source of income. A further 16 percent are in full-time employment, while 12 percent are in part-time employment or casual labor.

Fifteen percent of households (all of which are refugees) depend on grants from NGOs or donor agencies as their main source of income, and 14 percent have no source of income. A complete lack of income is particularly common in Kalobeyei town, where 27 percent state that they have no income at all. Farming is not widely practiced in the area as a "main" source of income.

Table 10: Main sources of household income over the last 12 months

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	1,001	260	468	63	210
Self-employment	25%	30%	24%	46%	13%
Full-time employment	16%	28%	13%	7%	9%
Grants from NGOs or donor agencies	15%	0%	15%	0%	39%
Part-time employment/ casual labor	12%	26%	8%	16%	1%
Donations/gifts from family and friends	8%	3%	14%	1%	5%
Farming/agriculture (both crop and livestock) – with a portion of the crop, animal, or produce being sold	1%	0%	1%	1%	0%
International remittances from friends and family	1%	0%	2%	0%	0%
Grants from government agencies	1%	0%	1%	0%	3%
Operating/renting transport vehicles (cars, trucks, motorbikes, bicycles, etc)	0%	0%	0%	0%	1%
No source of income	14%	12%	15%	27%	8%
Do not know	5%	0%	5%	0%	13%
Refused to answer	2%	0%	2%	0%	7%

Household ownership of electric devices

Ownership of electrical appliances is low across the study locations, with only 23 percent of households owning a radio and 21 percent owning a television. Less than 5 percent of the sample owns each of the other types of electrical devices. Kakuma town has the highest ownership levels of electrical devices.

94%

Households own a mobile phone

Table 11: Appliances in the household

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	1,001	260	468	63	210
Mobile phone(s)	94%	97%	97%	75%	88%
Radio	23%	38%	15%	31%	20%
Television	21%	29%	23%	15%	9%
Television decoder	4%	3%	6%	1%	2%
Security lights	3%	3%	1%	3%	5%
Computer/laptop	3%	5%	3%	1%	1%
Video player/DVD/VCR	2%	2%	2%	0%	2%
Blender	1%	0%	1%	0%	0%
Refrigerator	1%	1%	1%	3%	1%
Stand-alone freezer	1%	0%	1%	0%	1%
Electric iron	1%	3%	0%	0%	0%
None	4%	1%	3%	18%	7%

The majority of households own a mobile phone. This means phone-based communication could be used to inform households of opportunities that they could take advantage of. This can be done through bulk SMS messaging in Swahili.

Source: www.pexels.com

Source: www.pexels.com

The Impact of COVID-19

As in the broader Kenyan population, COVID-19 has had a negative impact on the income of many households in the Kakuma area. Fifty-five percent of respondents say that their household income has decreased due to the pandemic. The pandemic has affected refugees significantly more than host communities in Kakuma: 68 percent of refugees in Kakuma camp have seen their revenue decrease, compared to 34 percent of households in host communities in Kakuma town. In Kalobeyei, the pandemic has had a similar effect on refugees and host community members.

A few people have found opportunities to thrive, as 23 percent of households, especially those in Kakuma town, have seen their income increase.

Table 12: Household income now compared to before the COVID-19 crisis

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	1,001	260	468	63	210
Household income has increased	23%	54%	9%	31%	16%
Household income has decreased	55%	34%	68%	55%	55%
Household income has stayed the same	21%	13%	23%	13%	29%

2.2: Businesses

As discussed earlier, entrepreneurial activities and self-employment are the main means by which people make a living in the Kakuma and Kalobeyei areas. By far the most common type of business is retail enterprises, with a mix of a few other business types in the service area, as shown in Table 13.

Table 13: Types of businesses surveyed

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	150	40	85	10	15
Shop/supermarket	46%	92%	29%	56%	11%
Grocery shop/vegetable stall	19%	0%	29%	13%	22%
Restaurant/café/ hotel/bar/catering establishment	8%	8%	7%	10%	17%
Phone repair/charging shop	6%	0%	10%	0%	0%
Barber shop	4%	0%	4%	0%	11%
Clothes shop/boutique/ cosmetics shop	3%	0%	3%	0%	11%
Stationery shop/cyber café	2%	0%	3%	3%	0%
Salon	2%	0%	2%	0%	6%
Movie shop/gaming shop	2%	0%	3%	3%	0%
Photo studio	2%	0%	2%	0%	6%
Milk vendor	1%	0%	1%	0%	0%
Tailoring shop	1%	0%	1%	0%	6%
Butchery/meat and fish vendor	1%	0%	0%	13%	0%
Welding and fabrication shop	1%	0%	0%	0%	6%
Garage	1%	0%	1%	0%	0%
Hardware shop	1%	0%	1%	0%	6%
Charcoal vendor	1%	0%	1%	0%	0%
Posho mill	1%	0%	1%	3%	0%

15%

Business owners interviewed have no education

Profile of business owners

Most business owners in the refugee camps and settlement areas are male, whereas in towns the majority of business owners are women. The level of educational attainment is higher, on average, among business owners than among the household respondents. Only 15 percent of business owners have no formal education (compared to 36 percent of the household decision makers interviewed). Thus, there is a correlation between educational level and business ownership; education may be important for accessing the investment needed to set up a business and/or successfully managing it.

Table 14: Gender and education level of business owners

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	150	40	85	10	15
Male	56%	17%	74%	31%	72%
Female	44%	83%	26%	69%	28%
No formal education	15%	17%	10%	41%	17%
Some primary education	26%	33%	26%	13%	17%
Primary education completed	7%	8%	9%	3%	0%
Some secondary education	22%	17%	23%	13%	39%
Secondary education completed	14%	8%	18%	10%	11%
Post-secondary (college/university)	15%	16%	13%	19%	17%

100%

of business respondents in Kakuma town have declared a decrease in profits

Business profits

The businesses interviewed make an average monthly profit[13] of KES15,300 ($142), with businesses in Kakuma camp making slightly more money on average than others.

Table 15: Average business owner monthly profit

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	124	40	63	9	12
Average monthly profit (KES)	15,300	13,500	17,000	14,700	12,900

Note: All numbers are rounded to the nearest 100

The impact of COVID-19 on businesses

About 87 percent of the businesses across the study locations indicated that their income has decreased due to the COVID-19 pandemic. The negative shock on income has impacted 88 percent of businesses in host communities, slightly more than in refugee camps (80 percent). Significantly, all business respondents in Kakuma town declared a decrease in profits.

Table 16: Business income now compared to before the COVID-19 crisis

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	150	40	85	10	15
Business income has increased	6%	0%	8%	8%	11%
Business income has decreased	87%	100%	80%	85%	89%
Business income has stayed the same	6%	0%	9%	8%	0%
Refused to answer	2%	0%	3%	0%	0%

Electrical appliances that businesses own

Business owners provided information on the electrical appliances that they use within their businesses. Most businesses have a mobile phone (84 percent), radio (25 percent), and television (22 percent), which are likely used at the household level. Refrigerators (21 percent) and security lights (12 percent) are mentioned as being owned by businesses but not households, so it can be assumed that they are primarily for business use. Other electrical devices are noted in Table 17.

13 Revenue minus business expenses.

Table 17: Appliances in the businesses

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	150	40	85	10	15
Mobile phone(s)	84%	75%	86%	92%	94%
Radio	25%	25%	27%	28%	17%
Television	22%	17%	28%	15%	6%
Refrigerators	21%	25%	21%	23%	6%
Security lights	12%	17%	10%	15%	6%
Computer/laptop	8%	8%	8%	5%	11%
Television decoder	5%	8%	4%	10%	0%
Stand-alone generator	4%	8%	1%	3%	6%
Stand-alone freezer	3%	0%	4%	0%	0%
Printer	3%	0%	2%	3%	11%
Photocopy machine	3%	0%	3%	3%	11%
Laminating machine	3%	0%	3%	3%	11%
Video camera/ camcorder	3%	0%	3%	0%	11%
Hair dressing equipment	3%	0%	4%	0%	6%
Blender	2%	0%	3%	0%	0%
Electric iron	2%	8%	0%	0%	0%
Video player/DVD/VCR	2%	0%	3%	8%	0%
None	9%	25%	2%	8%	6%

It is anticipated that increasing the coverage of electric power would help these businesses meet their power needs for productive use.

3. Energy demand

03

3.1: Household energy use

3.1.1: Lighting

In Kenya, half of households are connected to the national electricity grid, about 19 percent use solar lighting, while 10 percent use paraffin lanterns.[14] Use of electric lighting is higher in urban than rural areas, where people are more likely to use alternatives such as paraffin tin lamps and paraffin lanterns such as the ones shown in Figure 2.

The picture is very different in Turkana West subcounty, where the most common sources of lighting are wood fires[15] (41 percent), rechargeable torches (21 percent), dry-cell torches (16 percent), and solar (10 percent).

Figure 2: Sample paraffin lantern and sample paraffin tin lamp

Hurricane lamp

Traditional tin lamp

Source: Wiley Online Library

Kakuma and Kalobeyei are different again, with solar lanterns being the primary source of household light (29 percent of households), followed by SHSs at 16 percent. Households in Kakuma town are much more likely than those in the other study areas to use solar lanterns or SHSs, presumably because they have a higher income than residents of the other areas. SHSs are hardly used at all in Kalobeyei settlement or town.

After solar, the most commonly used primary lighting sources are dry-cell torches (13 percent), mobile phones (11 percent), and electricity generated by local power producers (11 percent). No household reported using kerosene or paraffin lamps and lanterns; this is explained by the lack of a good supply of kerosene in the area.[16] Moreover, KPLC has little coverage in the area.

14 2019 Kenya National Population and Housing Census.
15 2019 Kenya National Population and Housing Census.
16 The supply-side assessment for this project did not find a single kerosene provider.

8%

Households reported having no means of lighting at night

Table 18: Household primary source of lighting

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	1,001	260	468	63	210
Solar lantern	29%	46%	22%	24%	23%
SHS	16%	27%	17%	7%	3%
Dry-cell torch	13%	6%	16%	12%	17%
Private electricity service provider	11%	0%	17%	10%	12%
Mobile phone[17]	11%	8%	13%	10%	11%
Electricity from Kenya Power	3%	8%	0%	13% [18]	0%
Firewood/twigs/wood waste	2%	0%	0%	7%	4%
Candles	1%	2%	0%	1%	2%
Other	6%	2%	8%	6%	8%
None	8%	2%	7%	6%	21%

Households in Kakuma camp and Kalobeyei settlement and town power their lights using energy from private electricity service providers. This source is not used at all in Kakuma town because there is no supply there. In Kakuma camp these private electricity service providers are unregulated, while in Kalobeyei an international private operator called Renewvia has installed a predominantly solar-powered mini-grid. About 8 percent of households in the study areas reported having no means of lighting at night; this was most prominent in Kalobeyei settlement, where over a fifth have no lighting.

Solar lanterns

As noted above, solar-powered lighting is the most used lighting source across the Kakuma-Kalobeyei area – 29 percent of households use it as a primary source of lighting, while 34 percent use it as a primary or secondary source. A challenge that households face with regards to solar lanterns is that their productivity is affected by bad weather (as mentioned by 48 percent of respondents who bought a solar lantern – see Table 19). As a result, households reliant on solar lanterns must find alternative sources of lighting during the rainy season. There has been recent growth in the use of solar lanterns, with the average user having started using this source two years ago. Households in Kalobeyei town were the last to start using them.

17 Temporary lighting source where the flashlight function is used to illuminate the house in a similar manner to a dry-cell torch.

18 While 13 percent of Kalobeyei town respondents indicated using KPLC power, it is understood that the grid connections have not yet been extended to Kalobeyei. As such, it is possible that respondents misunderstood the question and referred to electricity obtained from private providers.

$15.90

Average cost of a solar lantern

Fifty-six percent of households in Kakuma town own a solar lantern compared with over a quarter in each of the other areas.

How households acquire their solar lantern helps in understanding market dynamics and provides insight into likely future uptake and the method of acquisition among the population. First, it is important to note that not all households bought their lantern; 42 percent purchased theirs, while 43 percent received it for free from an NGO. According to UNHCR,[19] 36,000 households in the refugee camps were given a lantern by the IKEA Foundation through the Brighter Lives for Refugees campaign.[20] The remaining 14 percent received their lantern as a gift from a friend or family member.

Because of the free lanterns given out, use levels do not necessarily indicate preference or willingness to buy. The high usage does, however, mean that there is strong awareness of the solar product and how it is used, and its value in providing lighting. This will facilitate further development of the market.

Previous purchase price is a good indicator of the price that people will pay in future for an item. Householders who purchased their solar lantern spent an average of KES1,700 ($16). Models found in the Kalobeyei settlement area are cheaper, because of their output capacity, and were acquired for an average price of KES940 ($8.70).

Solar lantern purchases are most often funded from people's earnings. This is followed by being paid for in installments over an average of seven months on "hire-purchase," from savings, and by a loan. Given that a third of households used either credit or hire-purchase, a credit model to facilitate household acquisition of solar lanterns seems to be broadly familiar in the market and could be improved to increase uptake.

Table 19: Mode of funding for solar lantern purchase

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	144	58	57	5	25
Used my earnings/ income at the time	48%	66%	41%	60%	21%
Used my savings to purchase	17%	14%	11%	40%	36%
Bought from a hire-purchase institution	16%	10%	26%	0%	7%
Bought on credit/ obtained a loan	11%	8%	12%	0%	14%
Bought by a relative/ friend	4%	2%	4%	0%	7%
Sale of an item	2%	0%	1%	0%	7%
Used vouchers	1%	0%	1%	0%	0%
N/A	2%	0%	3%	0%	7%

19 UNHCR, UNHCR Kakuma Operation Hosts Ms Annelies Withhofs from IKEA Foundation, https://www.unhcr.org/ke/11580-unhcr-kakuma-operation-hosts-ms-annelies-withhofs-ikea-foundation.html

20 This initiative also put up 350 streetlights in Kalobeyei settlement and around public facilities.

16%

Households use SHSs to meet their lighting needs

However, surveyed households cited trying to raise money to fund the purchase of solar lanterns as a challenge. Furthermore, some feel that the payment terms provided by traders are unfavorable.

Table 20: Challenges households face with solar lanterns

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	143	57	57	5	25
Weather conditions, e.g. rainy season	48%	62%	34%	40%	50%
Expensive	18%	5%	21%	20%	43%
Not reliable	11%	14%	8%	20%	7%
Poor quality	9%	12%	10%	0%	0%
Nonflexible payment dates	6%	7%	5%	0%	7%
Unreliable supply, e.g. delays	4%	2%	4%	0%	7%
Unavailability	2%	0%	3%	0%	7%
None	10%	3%	19%	20%	0%

The quality of solar lanterns was mentioned by 9 percent. They feel that some are fragile and do not last long.

Addressing these barriers is likely to increase the uptake of solar lanterns. It would be helpful to support the distribution of higher-quality and weather-resistant products in the study locations, provided that their price aligns with household purchasing power (such as the average price mentioned above). In addition, credit schemes could increase ability to buy among those customers who do not yet have one.

Solar home systems

A total of 16 percent of households use an SHS as a primary source to meet their lighting needs (the percentage of those who have access to it stands at 18 percent). Use is most common in Kakuma town (27 percent) and Kakuma camp (17 percent). Only 7 percent of households in Kalobeyei town use an SHS, dropping to 3 percent in Kalobeyei settlement. Households tend to have an SHS with an average capacity of 100 watts, supported by a battery size of around 80 Ah. The SHSs are used by households for an average of 13 hours each day to support lighting needs and to power a few low-energy-consuming household appliances.

The average cost of buying and setting up a 100-watt SHS supported by an 80 Ah battery for households is KES28,264 ($262). To fund this acquisition, most households (79 percent) used their own earnings to pay in cash up front. A fifth paid for it in installments over a period of eight months. The main challenge cited by households is affordability; those who are not willing to buy it, say it is because of its high price.

Another barrier reported by supply-side actors is the challenge of finding local technicians to do the installation and maintenance. This could be addressed by developing a pool of local technicians who can be reached by consumers on demand.

75%

Consumers cited inconsistent electricity supply as the biggest challenge

Electricity from private electricity service providers

As shown in Table 18, only 11 percent of households use power provided by independent operators as a primary source of power (the percentage of those who have access to it is 13 percent). In the Kakuma and Kalobeyei areas these are mini-grids and unregulated electricity distributors using generator sets for lighting and powering electrical appliances. The households that use this power as a primary source are predominantly found in Kakuma camp (17 percent), and Kalobeyei town (10 percent) and settlement (12 percent). No household in Kakuma town was found using this power source.

On average, users have been using lighting powered by private electricity service providers for four years, mainly in Kakuma camp. Users in Kalobeyei town have been using this source of energy for an average period of one year, which is when Renewvia (a major provider in the area) started operating. Households with this type of power spend an average of KES1,058 ($9.60) per month on power bills, though this data is mostly from Kakuma camp due to small numbers in the sample using this power source in the other sample locations.

Table 21: Average monthly consumption of power supplied by private providers

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	108	99	7	2	2
Average consumption per month (KES)	1,057.6	1,081.6	925.0	300.0	300.0
Don't know	25%	23%	43%	0%	0%

The way that the private electricity service providers charge for their services varies. In Kakuma camp, households are charged a fixed monthly rate based on the number of appliances they wish to power. This is because the unregulated power suppliers in Kakuma camp lack metering systems. Surveyed households reported paying KES200 to KES12,000 for power supplied in an average month. Meanwhile, households in Kalobeyei have energy supplied by a regulated private operator, Renewvia, which charges a rate based on the amount of electricity consumed, with the average spend being around KES400 ($3.60) per month.

The biggest challenge faced by most consumers of this electricity in Kakuma camp is inconsistent supply, with a much smaller challenge being that it is too expensive (cited by 16 percent).

The private electricity service providers interviewed in Kakuma camp indicated that when their machines break down, they are often unable to find local technicians to do the repairs and have to seek support from neighboring towns such as Lokichar, Lodwar, and Eldoret. In some cases, if the issue causing the breakdown is complex, they must engage technicians from Kisumu, which is over 500 kilometers away, thus increasing both the cost of and time spent on the repair. These maintenance costs get passed on to consumers. Spare parts are difficult to find within the study locations and often have to be sourced from Kisumu, which creates further delays.

Issues with spare parts and lack of maintenance expertise can be addressed by supporting the training of local technicians and strengthening the supply chain for spare parts.

8%

Households using power supplied by KPLC for lighting

Table 22: Challenges in obtaining power from private electricity providers

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	106	99	7	7	2
Not reliable	45%	50%	0%	0%	0%
Delays in supply/ poor supply	30%	32%	0%	0%	0%
Weather conditions, e.g. rainy season	18%	14%	71%	71%	0%
Expensive	16%	16%	0%	0%	100%
Poor quality	6%	5%	29%	29%	0%
Long queues/ overloaded	5%	4%	0%	0%	0%
Nonflexible payment dates	5%	6%	0%	0%	0%
Unavailability	4%	5%	0%	0%	0%
Conflicts between communities	4%	4%	0%	0%	0%
Health problems, i.e. produce smoke	1%	1%	0%	0%	0%
It is used only for lighting	1%	1%	0%	0%	0%
None	5%	6%	0%	0%	0%

Electricity from KPLC

In Kakuma town, 8 percent of households reported using power supplied by KPLC as their primary source of lighting. KPLC is the national utility. Since 2018, Kakuma town has been connected to a KPLC electricity mini-grid powered by two diesel generators. KPLC does not reach the refugee camp or Kalobeyei settlement. However, it was observed during fieldwork that KPLC was expanding connections in host community areas.

4%

Businesses having access to a generator

Households spend about KES600 ($5.50) on KPLC power per month, which includes a consumption charge,[21] a fuel cost charge,[22] an inflation-adjustment cost,[23] a Water Resource Management Authority (WARMA) levy,[24] an Energy Regulatory Commission levy,[25] a Rural Electrification Fund levy,[26] and value-added tax. The challenges that households face include high connection fees, at KES15,000 ($137),[27] and delays in getting connected.

Generators (independently owned)

Household generator ownership in Kakuma and Kalobeyei is very low. Only seven households out of the entire sample reported using them – which is less than 1 percent ownership. Of the 159 businesses interviewed, only 5 percent indicated that they have access to a generator. Of the seven households using generators, six are refugee households and one is located in the host community area. Three of the seven generators are exclusively owned by the households while the other four are co-owned with other households. Some generators use petrol while others use diesel.

Challenges that generator users face include unavailable genuine spare parts, inadequate supply of diesel, and lack of qualified technicians to do repairs.

Table 23: Household ownership of generators

	Total
Sample size	7
Exclusively owned by the household	53%
Co-owned with other households	47%

3.1.2: Cooking

In Kenya, 55 percent of households use firewood for cooking, 24 percent use LPG, 12 percent use charcoal, and 8 percent use paraffin.[28] In Turkana West subcounty, firewood use is much higher than the national average, at 81 percent.[29] Similarly, in the Kakuma-Kalobeyei area, firewood is by far the main source of fuel for cooking (78 percent), with refugee households particularly reliant on it (92 percent).

It is only in Kakuma town where charcoal is more widely used than firewood (79 percent and 43 percent respectively). Across the study areas, 59 percent of households use charcoal. There is low usage of LPG across all locations; only in Kakuma town do a minority of households use it (15 percent). LPG has not yet penetrated refugee communities.

21 This is electricity consumption within the billing period or prepaid vending month in kilowatt-hours and shillings.
22 This is money used for generating electricity from thermal power plants. It varies monthly depending on the quantity of thermal generation and the cost of fuel.
23 An adjustment that varies according to the domestic and international inflation on cost of supply. It is adjusted every six months starting from January 1.
24 This is a levy passed to the WARMA for hydro-power generation of 1 megawatt and above. It is currently set at 0.05 cents per kilowatt-hour. In the prepaid token receipt, the WARMA levy is combined with the Energy Regulatory Commission levy.
25 This is a levy passed to the Energy Regulatory Commission to cover its operational costs. It is currently set at 3 cents per kilowatt-hour.
26 This is currently set at 5 percent of the cost of the units consumed and is passed to the Rural Electrification Authority for implementation of rural electrification projects.
27 KPLC website.
28 2019 Kenya Population and Housing Census, https://open.africa/dataset/2019-kenya-population-and-housing-census
29 Ibid.

$1

Average cost of firewood per bundle

Table 24: Household sources of energy for cooking

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	1,001	260	468	63	210
Firewood	78%	43%	92%	76%	92%
Charcoal	59%	79%	54%	40%	54%
LPG	4%	15%	0%	4%	0%
Private electricity service providers	1%	0%	2%	0%	3%
Paraffin/kerosene	1%	2%	1%	0%	0%

Each of these energy sources is reviewed in more detail below.

Firewood

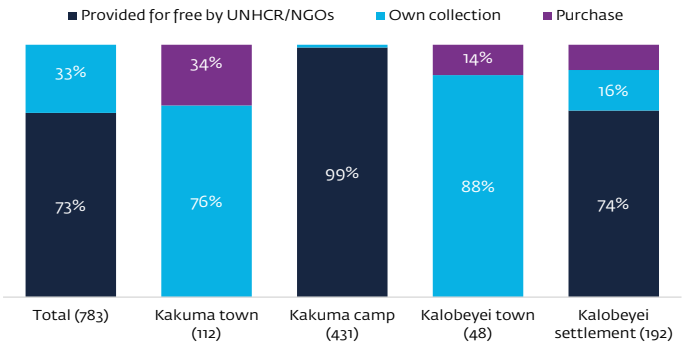
Households use an average of three bundles of firewood per week, with three bundles used by refugees and two by host households.

Figure 3: Average size of a firewood bundle sold by traders

Source: Taken by the Ipsos field team during data collection

Host community members mainly collect their own firewood (and also sell it to refugees), while the vast majority of refugees relied on firewood provided by UNHCR, which was replaced with cash transfers in 2021. Refugees also collect their own firewood (1 percent of households in Kakuma camp and 16 percent in Kalobeyei settlement) or buy it, especially residents of Kalobeyei settlement, where a majority purchase firewood.

Figure 4: Sources of firewood used for cooking in households



$10

Household average spend per month for the purchase of firewood

Firewood is usually collected by adult women (84 percent), who are sometimes assisted by children (female children – 13 percent and male children – 8 percent). Only 12 percent of men collect firewood. Some refugee households reported selling their firewood rations obtained from UNHCR to meet other short-term needs and then needing to buy firewood later at a higher price.

Clashes between refugees and host community members are said to happen when refugees sell their firewood, so refugees have to go out foraging in competition with host community members. Community members feel that since refugees are provided with firewood, they should not also be foraging for more from the host community areas. Cases of sexual abuse of females, including rape, have been reported and are a major concern.[30]

Households that purchase firewood buy it at an average price of KES100 ($1) per bundle. An average household spends about KES1,054 ($10) per month on firewood – which translates to an average of 10 bundles of firewood purchased. As illustrated in Table 25, Kakuma town residents spend significantly less on firewood than households in the other locations, which can be explained by their preference for charcoal.

Table 25: Monthly household expenditure on firewood

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	276	38	113	7	118
Average monthly expenditure on firewood (KES)	1,054	474	1,190	1,000	1,111

Households face several challenges in sourcing firewood, with cost being the main one. The affordability of firewood appears to be a major challenge in Kalobeyei settlement, which is likely due to higher dependence on buying firewood. Conflicts and attacks by thieves are a major concern particularly in Kalobeyei town, with two-thirds of respondents from the town reporting this issue.

Finally, a third of respondents in the host community reported long distances to the place of firewood collection as a challenge. Members of the host community were twice as likely to mention the adverse health effects arising from firewood use than refugees.

30 Reported in key informant interviews.

Source: www.pexels.com

Table 26: Challenges households face in sourcing firewood

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	783	112	431	48	192
Expensive	37%	33%	32%	10%	57%
Unavailability	22%	15%	29%	6%	17%
Conflicts between communities	21%	30%	20%	45%	11%
Long distance, i.e. tedious	12%	33%	8%	35%	1%
Health problems, i.e. produce smoke	6%	14%	6%	12%	1%
Weather conditions, e.g. rainy season	5%	6%	6%	2%	6%
Unreliable supply	5%	0%	9%	0%	3%
Thirst/hunger	3%	7%	0%	20%	1%
Long queues	3%	0%	6%	0%	1%
Barter trade, i.e. exchange of food for firewood	3%	0%	4%	0%	2%
Poor quality	1%	2%	1%	2%	0%
None	9%	2%	10%	4%	13%

96%

Purchase their charcoal

Charcoal

As previously discussed, charcoal featured as an important source of energy for cooking in Kakuma town. Most charcoal users buy it themselves, including 3 percent of refugees in Kakuma camp who trade their food rations to obtain charcoal. Production of charcoal mostly occurs in the host community, with 4 percent of households in Kakuma and Kalobeyei towns producing their own charcoal. Household charcoal sources are shown in Table 27.

Table 27: Sources of charcoal used by households

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	595	206	250	25	113
Purchased	96%	95%	96%	96%	98%
Own charcoal – burnt by a household member/household	2%	4%	1%	4%	0%
Provided for free by UNHCR/NGOs	1%	0%	1%	0%	2%
Trading food for charcoal	1%	0%	3%	0%	0%
From relatives	0%	1%	0%	0%	0%

In terms of the unit of charcoal purchased, 61 percent buy a *debe* and 13 percent buy their charcoal in a sack. A *debe* is a container usually cut out of a 20-liter plastic jerry can.

Figure 5: Sample debe used to measure charcoal

Source: Taken by the Ipsos field team during data collection

Most households use an average of two *debes* of charcoal per week, with consumption higher in Kakuma town and refugee camps than in Kalobeyei.

Table 28: Amount of charcoal used by a household in a week

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	595	206	250	25	113
Average weekly consumption	2.2	2.3	2.4	1.1	1.6

The price of a *debe* of charcoal ranges from KES200 to KES300 ($2 to $3). The average monthly expenditure per household is KES1,150 ($10), with little variance across the different areas. Charcoal is a readily available commodity as households often purchase it from a local trader close to the area where they live.

Table 29: Average monthly household expenditure on charcoal

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	509	174	224	24	88
Average monthly expenditure on charcoal (KES)	1,150	1,101	1,259	1,376	908

The challenges faced by households in accessing charcoal for cooking include its high price (as mentioned by 75 percent of households) and inconsistent supply during the rainy season (25 percent), which drives up the price. Poor quality (4 percent) and health problems from the smoke (mentioned by 4 percent of respondents in the host community) are other issues.

Liquefied petroleum gas for cooking

LPG is not widely used. Only 15 percent of households in Kakuma town and 4 percent in Kalobeyei town use it for cooking. Refugee households did not report using LPG. The average cylinder size owned by 50 percent of households is 6 kilograms. Thirty percent own a 3 kilogram cylinder, 11 percent own a 13 kilogram cylinder, and the rest own a 5 kilogram, 7.7 kilogram, or 8 kilogram cylinder.

To purchase the initial gas cylinder and cooker, seven out of every 10 households with LPG used their earnings at the time, while 23 percent used their accumulated savings. Five percent were gifted their initial cylinder and cooker by a family member or friend and only 2 percent indicated that they bought their initial cylinder and cooker on credit.

Two types of cylinders were reviewed in more detail in the survey: the 6 kilogram and 13 kilogram cylinders.

Refilling a 6 kilogram cylinder costs on average KES1,400 ($13), while refilling a 13 kilogram cylinder costs KES3,000 ($28). The price of each cylinder size depends on the brand, with the most expensive being Total Kenya and the cheapest being Hashi Gas.

58%

Cite main challenge with LPG is the initial purchase cost of the cylinder

Table 30: Cost of acquiring an LPG cylinder

Cylinder size	Brand	Average cost of cylinder and gas (KES)	Average cost of gas refill (KES)
6 kgs	Total	6,000	1,500
	Hashi	4,500	1,300
	Pro Gas	5,500	1,200
13 kgs	Total	8,000	3,300
	Hashi	7,500	2,800
	Afrigas	6,500	3,300
	Pro Gas	6,500	2,500

The main challenge with LPG is the initial purchase cost, as reported by 58 percent of respondents. Other issues are lack of availability (9 percent) and gas running out sooner than expected (7 percent).

3.2: Business energy demand

Businesses use energy for lighting or other productive purposes relating to their business type.

3.2.1: Lighting

SHSs, electricity generated by private electricity service providers, and solar lanterns are the main lighting sources used by businesses. However, in Kakuma town, businesses are connected to the main grid rather than private operators.

Table 31: Primary sources of lighting for businesses

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	150	40	85	10	15
SHS	27%	25%	31%	28%	11%
Solar lanterns	22%	33%	18%	26%	11%
Private electricity service providers	21%	0%	27%	15%	44%
Electricity from KPLC	5%	17%	0%	8%	0%
Other	5%	0%	7%	3%	11%
Dry-cell torch	3%	0%	2%	3%	11%
Mobile phone	3%	8%	1%	3%	0%
Candles	2%	8%	0%	0%	0%
Paraffin/kerosene	1%	0%	1%	0%	0%

11%

Businesses do not have a source of lighting

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Personal or shared generators (petrol/diesel)	1%	0%	2%	0%	0%
None	11%	8%	11%	15%	11%

Overall, business consumers seem to have slightly better access to energy solutions for lighting than households. However, 11 percent of the interviewed businesses do not have a source of lighting, which limits their ability to operate after dark should they wish to do so.

Solar lanterns

Twenty-four percent of the business owners interviewed declared using solar lanterns. Business owners have had solar lanterns for an average of about 1.5 years. The majority purchased their lantern for about KES1,278 ($11.80), while the rest received a free lantern that has a lower lighting capacity than that commonly found in households. Most businesses paid for their lantern up front (74 percent), while the rest paid in installments over a period of eight months. Thus, a credit or a staggered payment model to facilitate the acquisition of solar lanterns may be needed for some businesses.

The challenges businesses face when using solar lanterns are similar to those faced by households: the cost of the lanterns, they do not work in the rainy season,[31] and they break down easily. A minority, 7 percent, said that solar lanterns cannot power the kind of electrical equipment their business needs.

Solar home systems

Thirty percent of the interviewed businesses reported using SHSs. The average capacity of the SHS used by businesses is 151 watts, supported by a battery size of 100 Ah, a higher capacity than that found in households. Energy from this source is used for around seven hours a day – with most of this power being used for powering electrical equipment. The cost of an SHS is reported to be KES31,570 ($292).[32] Although SHSs are also sold locally, most of the higher-capacity ones are sourced from other regions. Most businesses buy SHSs with cash up front from their earnings, although a few paid in installments over six months.

Private electricity service providers

Twenty-six percent of the interviewed businesses declared using power for lighting from private electricity service providers. Businesses using this power source have been using it for around three years, although businesses in Kakuma camp have been using it for longer, presumably because of the prevalence of unregulated private operators there. Kalobeyei only recently saw an expansion of a private operator (Renewvia) regulated by EPRA.

31 The short rainy season occurs between November and December, while the long rains start in mid-March and continue until June.
32 Averaged.

Table 32: Average length of time businesses have used electricity from private electricity service providers

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	29	0	23	2	5
Average duration in years	3.2	-	3.5	1.8	1.0

Businesses spend on average about KES2,568 ($24) per month on electricity bills. However, some pay as much as KES15,000 ($137) per month to access this source of energy for their productive use – and these are businesses that have many electrical appliances that demand a higher electric power consumption to run.

Table 33: Monthly expenditure on energy supplied by private operators – businesses

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	37	0	30	1	6
Average monthly expenditure (KES)	2,568	-	2,984	733	653
Maximum monthly expenditure (KES)	15,000	-	15,000	1,000	1,500
Minimum monthly expenditure (KES)	50	-	500	200	50

This power solution is mainly charged at a fixed rate (64 percent). About 36 percent of respondents reported that the amount charged varies every month, as shown in Table 34, with this being predominantly the case in Kalobeyei.

Table 34: Mode of payment for power supplied by private electricity service providers

	Total
Sample size	40
Consumption varies month on month	36%
This is a fixed rate charged to anyone connected	64%

The challenges that households face in accessing this source of power also apply to businesses. In Kakuma, these include inconsistent power supply (47 percent), technical/mechanical issues that disrupt normal power supply and take a long time to resolve (35 percent), short operational time (21 percent), high cost (16 percent), and poor customer service (7 percent). About half of respondents in Kalobeyei indicated that they experience blackouts during rainy days, when there is low sunlight absorption.

Electricity from KPLC

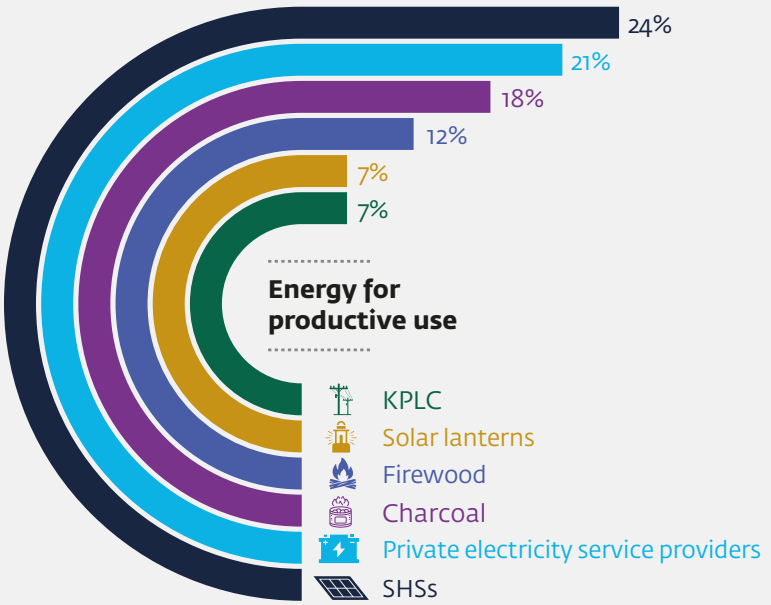
Just under one-fifth (17 percent) of businesses in Kakuma town use electricity from KPLC as their primary source of lighting. They have been connected for two years on average and report a monthly consumption cost of KES1,125 ($10).[33]

Generators

Only seven businesses (5 percent) in the sample use generators. Four are owned by refugee businesses and three by host community businesses. Six generators are solely owned by the business and one is co-owned with 13 other businesses.

These generators run on diesel and challenges mentioned include unavailability of genuine spare parts, inadequate supply of diesel, and lack of qualified technicians to do repairs.

33 Averaged.



3.2.2: Energy for productive use

Productive energy use refers to the commercial consumption of energy to produce goods or services. The study areas have predominantly small-scale businesses that are not energy intensive; 60 percent of the surveyed businesses are shops, groceries, and vegetable stalls.

SHSs are the most popular power source among businesses for productive use (24 percent). The next most popular sources are private electricity service providers (21 percent), charcoal (18 percent), firewood (12 percent), solar lanterns (7 percent), and KPLC (7 percent).

Energy sources used for productive use are fairly consistent across business types, although grocery shops are more likely to use private electricity service providers (26 percent) and less likely to use SHSs (only 6 percent) than other business types. A higher proportion of shops use KPLC electricity (7 percent) than other business types. Only 11 percent of businesses indicated that they use more than one source of energy (most often a combination of charcoal and firewood for catering purposes).

Businesses use SHSs, private electricity service providers, and KPLC electricity both for lighting and to power electrical equipment. For all three energy sources, around 60 percent is used for electrical appliances, while the remaining share is dedicated to lighting.[34] Among businesses that own power-intensive appliances such as a television, a refrigerator, or security lights, the use of the three energy sources is significantly higher: 54 percent use SHSs (compared to 16 percent for those without power-intensive appliances), 32 percent use private electricity service providers (compared to 18 percent), and 6 percent use KPLC electricity (compared to 2 percent).

The SHS monthly demand in number of hours from these businesses is 1.4 times higher than from businesses without power-intensive appliances, and their consumption of power (in kilowatt-hours) from private providers is also reported to be 2.5 times higher.

34 This estimate is based on self-reporting by businesses on what proportion of power is used for lighting, cooking, and powering electric equipment.

Firewood and charcoal, on the other hand, are exclusively used for catering purposes; 57 percent of catering businesses use charcoal for cooking, while 21 percent use firewood.

Businesses with access to energy earn on average 2.9 times more than businesses without a source of energy.

Among the businesses interviewed, almost a third do not use energy for productive use, while 11 percent do not even have access to energy for lighting. The average monthly income of businesses that consume energy for productive purposes is KES18,691 ($170), against KES8,905 ($81) for those that do not. The difference is greater between businesses with access to electricity for lighting and businesses without: KES17,032 ($155) for the former compared to KES5,844 ($53) for the latter.

In refugee camps, a higher proportion of male business owners use energy for productive purposes than female business owners. Among male business owners, 80 percent use at least one source of energy for productive purposes, compared to only 61 percent of female business owners. This may partly explain the difference in monthly income earned by females and males (1.6 times higher for the latter).

In host communities, where, on average, female business owners indicated a higher use of energy for productive purposes than men (78 percent against 50 percent), the average monthly income of females is 1.6 times higher than for males.[35]

There are, however, no significant gender-based differences in access to electricity for lighting, both in host communities and refugee camps.

35 The sample size is limited (34 female and 12 male business owners); as such, it is difficult to generalize for the whole population.

3.3: Energy used by schools, hospitals, and humanitarian organizations

Access to inexpensive, sustainable energy sources for schools, health-care centers, businesses, and community facilities is important yet lacking.[36] Indeed, such facilities mainly rely on energy obtained from private electricity service providers, individually owned diesel generators, or solar systems installed at the facility.

UNHCR and the World Food Programme use diesel generators to power their operations in Kakuma. Humanitarian organizations spend considerable amounts of funding on fuel to operate diesel generators that provide power to water pumps, schools, clinics, and other social institutions.[37]

It is reported that six facilities (schools and clinics) were supported with the installation of 800-watt solar systems in Kakuma camp by OVO Foundation and Energy 4 Impact, under Project Jua.[38]

The International Rescue Committee runs six health clinics in the study locations. Of these, three are connected to a solar system, while the rest run off diesel generators.[39]

Lutheran World Federation, which operates in Kakuma camp and Kalobeyei settlement, provided 24 schools in Kakuma and five sites in Kalobeyei with internal and street lighting (to improve security) through the use of decentralized stand-alone solar.[40]

36 Energy for Impact, press release: Energy 4 Impact leading innovative clean energy and livelihood initiatives for Kakuma refugees, https://www.sun-connect-news.org/news/details/press-release-energy-4-impact-leading-innovative-clean-energy-and-livelihood-initiatives-for-kakuma/

37 Mohammed Yusuf, Carol Guensburg, VOA, Empowering Refugees through Energy, https://reliefweb.int/report/kenya/empowering-refugees-through-energy

38 Energy4Impact, Smart Communities Coalition – Make Change Pilot; Assessing the Potential of Off-Grid Power Interventions in Turkana County with a Focus on Communities around Kakuma and Kalobeyei, https://energy4impact.org/file/2087/download?token=BsWZzcRf

39 Ibid.

40 Ibid.

Recently, ESDS Kenya supported the COVID-19 response measures of local authorities and UNHCR by electrifying facilities in Kalobeyei settlement and host community town to support efforts to contain the pandemic.[41] As a result of this initiative, three health facilities providing medical services to refugees and the host community, four schools earmarked as isolation centers, and one horticultural farm run by the World Food Programme sustaining the food supply were connected to two existing mini-grids built with the support of EnDev in Kalobeyei settlement and town.[42]

The UNHCR Sub-Office secured a $3.5 million COVID-19 Energy Response Fund to explore sustainable energy solutions through renewable energy systems for 13 identified COVID-19 isolation and quarantine centers (seven in Kakuma and six in Kalobeyei settlement).[43] The renewable energy systems in these facilities will remain operational and continue to serve the communities after COVID-19. UNHCR and its partners have invested in training solar technicians to increase capacity for installation and maintenance of solar infrastructure. The local capacity to implement this project is thus readily available.[44]

It is clear that these government and social facilities rely on local, donor-supported initiatives to meet their energy needs. In the longer term, a sustainable and cheaper solution is needed.

UNHCR has been taking steps to reduce its environmental footprint by shifting from diesel generators to solar energy to power its compounds, premises, and offices. The UNHCR Green Fund, established in 2020, aims to finance solar power generation projects at 10 UNHCR field sites in Kenya, Ethiopia, and Uganda. Each project size will range from 60 kW to 500 kW, with a total capacity of up to 1,800 kW. In 2021, UNHCR issued a tender that aims to attract renewable energy providers via multi-year power purchase agreements. The results of the tender are not yet known at the time of writing.

41 Energypedia, Expanding mini-grids during Covid-19 – Experiences from Kalobeyei, https://energypedia.info/wiki/Expanding_mini-grids_during_Covid-19_%E2%80%93_Experiences_from_Kalobeyei

42 Ibid.

43 UNHCR, Monthly Operational Update for the Kakuma Camp and Kalobeyei Settlement for 1–31 January 2021, https://www.unhcr.org/ke/wp-content/uploads/sites/2/2021/03/UNHCR_Kakuma_January-2021_Operational-Updates-1.pdf

44 Ibid.

04

4. Willingness and ability to pay for energy sources

4.1: Households' preferred energy sources

Households were asked what sources of energy they would like to have for cooking and lighting, if their means allowed.

For lighting, electric power – whether from KPLC or private suppliers – is the preferred source of energy, followed by SHSs and solar lanterns. For all three energy sources, providing lighting to enable schoolchildren to study in the evening is the main motivation. For those who do not have electric power, the main motivation is to enable school-going children to study in the evening (59 percent).

This is followed by wanting to have a more consistent supply of electricity (29 percent), wanting to start a family business or operate an existing one for longer hours (7 percent), and wanting to improve security (5 percent).

As noted in the demographics section, households have an average of four children, and those of school-going age need to study for about two to three hours each night.

For those who were not willing to get connected to this power source, affordability was the main barrier for 89 percent of households. The same motivations and barriers were found for SHSs and solar lanterns. Those unwilling to purchase a solar lantern said that it was not affordable (56 percent), that they had an alternative solution (22 percent), or that they were not interested (6 percent).

Table 35: Aspirational sources of energy for cooking and lighting in households

	Total	Kakuma camp	Kalobeyei settlement	Kakuma town	Kalobeyei town
Electric power from KPLC or private operators	80%	76%	78%	89%	84%
SHS	71%	70%	80%	72%	51%
Solar lantern	62%	61%	77%	61%	43%
LPG	59%	53%	71%	73%	52%
Biogas digester	35%	28%	42%	44%	57%

Note: Sample is based on all households that did not have an energy source

For cooking, LPG is the preferred fuel because it is quicker to prepare or warm meals and it offers a cleaner cooking experience. Those who are not interested in LPG primarily cited as reasons the high initial cost and the high price of gas refills.

4.2: Willingness to pay by energy source

Table 36 summarizes the overall results for households' willingness to pay across the different energy sources.

Table 36: Percent of households that would definitely pay for energy source at indicated prices

	Electric power from KPLC or private operators	SHS	Solar lantern	LPG cylinder and gas
Out of all households surveyed, percentage that did not have the energy source	86%	82%	66%	96%
Out of all households that did not have the energy source, percentage that would be interested in purchasing at indicated price	81%	58%	76%	66%
Out of all households that did not have the energy source, percentage that would definitely be interested in purchasing at indicated price	76%	59%	64%	65%
Out of all households surveyed, percentage that would definitely purchase at indicated price	58%	20%	20%	25%
Average price households would be willing to pay (KES)	600 ($5.50)	10,000 ($93)	3,174 ($29)	2,500 ($22.70)

$5.50

Average price households are willing to pay per month

Electric power supplied by KPLC and private operators

Eighty-six percent of households do not have electric power from either KPLC or private providers (both regulated and unregulated). Of these, 71 percent would be willing to pay for efficient electricity from KPLC and regulated private mini-grid operators for all household needs, while 10 percent would be interested in electricity for lighting only. The demand for electricity is higher in host community households than in the camps or settlements (as shown in Table 37).

Table 37: Percentage of households willing to pay for electricity from KPLC or private mini-grids

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	948	238	468	55	187
Would be willing to pay for efficient electricity for all household needs (with percentage interested in electricity for lighting only)	81% (10%)	89% (9%)	76% (8%)	84 (12%)	78% (13%)
Would not be willing to pay for electricity	19%	11%	24%	16%	22%

Considering that the study area has about 56,114[45] households in total, there is a potential market of 43,012 households for electric power connections.

Households are willing to pay an average price of KES600 ($5.50) per month to have their rooms lit and electrical equipment powered on demand. A consumption-based payment model,[46] such as the one adopted by Renewvia, rather than a flat fee, would be preferable.

Table 38: Amount households are willing to pay for electricity from KPLC or private mini-grids

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	763	213	358	46	146
Average price per month (KES)	612	718	572	284	657

Respondents who were totally sure they would pay for this energy source accounted for 76 percent of those who expressed willingness to pay the market price. This shows that 58 percent of households would definitely pay for KPLC or private mini-grid electricity at an average price of KES600 ($5.50).

45 This number is computed from various datasets. According to IFC's study *Kakuma as a Marketplace*, there are about 60,000 people living in Kakuma town. This figure was used to estimate the number of households, by dividing this by the average household size in this area – which is 5.3 people, according to the 2019 Kenya Population and Housing Census. This provides an estimate of 11,321 host community households in Kakuma town. For the Kakuma refugee households, UNHCR data showed that there are 36,714 refugee households in Kakuma refugee camp. The Kalobeyei town population was estimated from a study by Renewvia, working with GIZ, that showed that there are 3,500 people living there. This number was divided by the average household size of 5.3 people to estimate the number of households: 660. For Kalobeyei settlement, UNHCR data on population distribution and number of households per camp showed that there were around 7,419 households at the time of data collection. A summation of these household number estimates shows that there are about 56,114 households.

46 The consumption-based model lets consumers pay for the service based on the units they have consumed. Pricing is therefore calculated using a unit price.

$14.60

Average spend per month on energy solutions

Table 39: Percentage of households that are sure they are willing to pay for electricity from KPLC or private mini-grids at the indicated price

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	763	213	358	46	146
Totally sure	76%	84%	74%	57%	78%
Somewhat sure	21%	13%	23%	39%	22%
Somewhat unsure	2%	3%	3%	4%	0%
Totally unsure	0%	0%	1%	0%	0%

When asked how they would meet the monthly cost of electric power, 64 percent of households mentioned that they would be comfortable using money currently being used to pay for other energy solutions. Considering that households interviewed are spending an average of KES1,600 ($14.60) per month on energy solutions, this proposed price of KES600 ($5.50) per month sounds realistic from the consumer point of view.

Demand for SHSs

Eighty-two percent of households do not have an SHS. Of these, 53 percent have previously considered acquiring one, while 72 percent would be interested in purchasing one if they had the opportunity. The willingness to acquire an SHS was slightly higher in Kalobeyei settlement and lower in Kalobeyei town than in other locations.

Fifty-eight percent of respondents who were interested in SHSs would be willing to pay KES10,000 ($92) for a low-capacity SHS.

Table 40: Average price that households are willing to pay for an SHS

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	342	74	161	9	99
Average price (KES)	10,063	12,080	12,063	9,555	5,359

Fifty-nine percent of respondents who expressed willingness to pay KES10,000 were totally sure they would purchase an SHS.

$29

Average price for those who were willing to purchase a solar lantern

Table 41: Percentage of households that are sure they are willing to pay for an SHS at market price

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	342	74	161	9	99
Totally sure	59%	59%	58%	70%	59%
Somewhat sure	31%	41%	25%	20%	36%
Somewhat unsure	7%	0%	12%	10%	4%
Totally unsure	3%	0%	5%	0%	2%

Demand for solar lanterns

Of the 66 percent of households that do not have a solar lantern, 64 percent would be willing to pay for one. Because most households need two rooms to be lit at a time, two-thirds of respondents interested in a solar lantern would prefer buying one solar unit connected to multiple bulbs. They also want it to charge phones, radios, and other devices. Of those who were willing to purchase a solar lantern, 76 percent were willing to pay an average price of KES3,174 ($29), although they would need to work and save for some time to be able to afford it.

Table 42: Average price that households are willing to pay for solar lanterns

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	319	51	162	18	88
Average price (KES)	3,174	5,117	3,580	3,505	1,241

However, only 64 percent of the households are completely sure they would purchase a solar lantern at that price, as shown in Table 43. Kakuma town has the highest proportion of households that are completely sure (75 percent).

Table 43: Percentage of households that are sure they are willing to pay for solar lanterns at market price

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	319	51	162	18	88
Totally sure	64%	75%	59%	68%	66%
Somewhat sure	29%	23%	29%	21%	34%
Somewhat unsure	5%	0%	9%	11%	0%
Totally unsure	2%	2%	3%	0%	0%

Thus, in total, 20 percent of households would definitely be willing to pay KES3,174 ($29) for a solar lantern.

Demand for LPG

Ninety-six percent of households do not have LPG. Of these, 46 percent have considered acquiring it and 61 percent would be interested in acquiring it if they had the opportunity. The demand for LPG appears to be slightly higher in the refugee households than in the host community households. Of those households interested in purchasing LPG, 66 percent would be interested in purchasing a cylinder and gas at the current market price. However, these households admit that they would not be able to afford the initial acquisition cost as a lump sum payment.

Household respondents proposed an average initial acquisition price of KES2,500 ($22.70) for the LPG cylinder and gas. The current market price for a 6 kilogram cylinder and gas is higher than that, meaning that a 3 kilogram cylinder is likely to be more affordable. A simple burner is estimated to cost KES600 ($5.50).

As uptake of LPG is subject to households being able to afford the initial investment cost, initiatives to address this would help improve current rates of acquisition. Considering that 43 percent of interested households would need to work and save for some time to afford LPG, a credit purchase or a staggered upfront payment model looks promising.

Table 44: Amount that households are willing to pay for LPG cylinder and gas

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	348	79	165	16	88
Average price (KES)	2,504	3,175	2,541	3,007	1,738

Sixty-five percent of households that expressed willingness to purchase an LPG cylinder and gas were totally sure they would do so at an average price of KES2,500 ($22.70). This translates to 25 percent of households.

Table 45: Percentage of households that are sure they are willing to pay for LPG at market price

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	388	92	171	17	108
Totally sure	65%	76%	57%	83%	67%
Somewhat sure	30%	20%	35%	17%	33%
Somewhat unsure	5%	4%	9%	0%	0%
Totally unsure	0%	0%	0%	0%	0%

4.3: Businesses' preferred energy sources

Business owners stated similar preferences for energy to household respondents. Electric power from KPLC or private operators has the highest preference score (92 percent), followed by SHSs (63 percent) and solar lanterns (52 percent). The motivations in order of priority are the possibility of longer operating hours (51 percent), starting another income-generating activity (26 percent), and having a more consistent power supply (9 percent).[47]

Table 46: Aspirational sources of energy

	Total	Kakuma camp	Kalobeyei settlement	Kakuma town	Kalobeyei town
Electric power from KPLC or private operators	92%	93%	80%	100%	91%
SHS	63%	60%	63%	78%	64%
LPG	40%	39%	28%	83%	36%
Solar lantern	52%	42%	67%	89%	60%
Biogas digester	20%	23%	17%	17%	15%

High cost was the major reason why businesses were not ready to adopt any of the three solutions. This was particularly true for KPLC electricity (83 percent) and SHSs (50 percent). Only 30 percent of respondents considered solar lanterns to be unaffordable.

4.4: Willingness to pay by energy source

Table 47 summarizes the willingness of businesses to pay for the different energy sources.

Table 47: Percentage of businesses that would definitely pay for energy source at market price

	Electric power from KPLC or private operators	SHS	Solar lantern
Out of all businesses surveyed, percentage that did not have an energy source	65%	71%	79%
Out of all businesses that did not have an energy source, percentage that would be interested in purchasing at market price	94%	85%	90%
Out of all businesses that did not have an energy source, percentage that would definitely be interested in purchasing at market price	78%	64%	68%

47 Percentages shown refer to electric power, but the same reasons were given for SHSs and solar lanterns.

	Electric power from KPLC or private operators	SHS	Solar lantern
Out of all businesses surveyed, percentage that would definitely purchase at market price	65%	26%	28%
Average price businesses would be willing to pay (KES)	1,200 ($11)	15,638 ($145)	5,917 ($55)

Demand for electricity from KPLC or private operators

Eighty-nine percent of businesses are not connected to electricity, whether from KPLC or private providers. Of these, 84 percent would be willing to pay for efficient electricity for all business needs and 10 percent would be willing to pay for electricity for lighting only. As with the households, 75 percent of businesses indicated that they would be comfortable using the money currently being used to pay for energy to access electricity from this source.

Table 48: Percentage of businesses willing to pay for electricity from KPLC or private mini-grids

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	133	27	85	9	12
Would be willing to pay for efficient electricity for all business needs	84%	100%	82%	83%	60%
Would be willing to pay for electricity for lighting only	10%	0%	11%	8%	20%
Would not be willing to pay for electricity	7%	0%	7%	8%	20%

Of the businesses that would be interested in paying for electricity from KPLC or private mini-grids, the average price they would be willing to pay to have rooms lit and electrical equipment powered all the time is KES1,200 ($11) per month.

Table 49: Average price that businesses are willing to pay for electricity (KPLC or mini-grid)

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	124	27	79	8	10
Average price per month (KES)	1,256	938	1,379	849	1,467

Seventy-eight percent of businesses were totally sure they would pay KES1,200 ($11) per month on average (a price that businesses indicated as affordable) for power from KPLC or mini-grids.

Table 50: Percentage of businesses that are sure they are willing to pay for grid or mini-grid electricity at market price

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	124	27	79	8	10
Totally sure	78%	100%	67%	91%	100%
Somewhat sure	17%	0%	25%	9%	0%
Somewhat unsure	4%	0%	6%	0%	0%
Totally unsure	2%	0%	2%	0%	0%

Demand for SHSs

Seventy-one percent of businesses do not have an SHS. Of these, 59 percent have considered acquiring an SHS and 66 percent would be interested in paying for one if they had the opportunity. The demand for SHSs is highest in Kakuma town. When all surveyed businesses are considered, 24 percent would be willing to purchase an SHS for about KES15,638 ($145), which falls within the current market price range of between KES9,000 and KES23,000 in the study areas.

Table 51: Average price that businesses are willing to pay for an SHS

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	60	23	25	5	7
Average price (KES)	15,638	15,714	17,296	11,167	12,125

Sixty-four percent of the surveyed businesses who mentioned being willing to buy an SHS are totally sure they can pay KES15,638 and above. Of these, 36 percent said they needed to save for some time or access credit to afford the purchase. As with the households, affordability based on an upfront payment is a major concern. When all business respondents are considered, 26 percent of them would definitely pay KES15,638 and above for an SHS.

Table 52: Percentage of businesses that are sure they are willing to pay for an SHS at market price

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	60	23	25	5	7
Totally sure	64%	71%	52%	44%	100%
Somewhat sure	34%	29%	44%	50%	0%
Somewhat unsure	2%	0%	4%	6%	0%
Totally unsure	0%	0%	0%	0%	0%

Demand for solar lanterns

Seventy-nine percent of businesses do not have a solar lantern. Among these, 40 percent have considered using one for lighting and 58 percent would be willing to buy one if they had the opportunity. As these businesses would need to light up around two rooms concurrently using these solar lanterns, most (71 percent) would prefer buying one solar unit connected to multiple bulbs that can charge/power phones, radios, and other devices. This is valuable information for any provider seeking to meet this potential demand. Of those businesses that would be interested in paying for a solar lantern, 90 percent indicated that they would be willing to pay about KES5,917 ($55) on average.

It should be noted that some businesses use the same lanterns in their business as their household, or the household is actually the business premises, so home and business usage is not necessarily distinct.

Table 53: Average price that businesses would be willing to pay for solar lanterns

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	62	27	25	4	7
Average price (KES)	5,917	3,938	9,500	4,375	1,588

Of the businesses that would purchase a solar lantern at the average price of KES5,917 ($55), 68 percent were completely sure they would buy a solar lantern. This translates to 28 percent of the businesses surveyed.

Table 54: Percentage of businesses that are sure they are willing to pay for solar lanterns at market price

	Total	Kakuma town	Kakuma camp	Kalobeyei town	Kalobeyei settlement
Sample size	62	27	25	4	7
Totally sure	68%	75%	58%	75%	75%
Somewhat sure	25%	13%	38%	25%	25%
Somewhat unsure	5%	13%	0%	0%	0%
Totally unsure	2%	0%	4%	0%	0%

4.5: Ability to pay

The household respondent's or business owner's ability to pay is determined by their current expenditure on energy. It is assumed that they are in a position to shift this payment to alternative forms of energy should they be able and willing to do so.

4.5.1: Households

An average household spends about KES1,600 ($15) in total on energy solutions in a month. Households in Kakuma town seem to spend more than those elsewhere. This is against an average monthly income of KES9,700 ($90) per household. An average household spends about 17 percent of its income on energy solutions.

Table 55: Estimated total monthly household spend on energy solutions

	Total	Kakuma camp	Kalobeyei settlement	Kakuma town	Kalobeyei town
Sample size	708	382	97	198	31
Average spend per month on all energy needs (KES)	1,600	1,600	1,300	1,900	1,600

Note: All numbers are rounded to the nearest 100

Most households do not have a steady income flow; as such, they may need credit products and solutions that can accommodate erratic cash flows. Nevertheless, these households have unmet energy needs that could be addressed by enabling access to electric power. For example, nearly all (95 percent) refugee households have at least one mobile phone. Many households (48 percent) indicated that they charge the phones at a phone-charging kiosk, 39 percent charge them at home, while 12 percent charge them at a relative's or friend's house. Most households in Kalobeyei settlement (68 percent) rely on phone-charging kiosks. The cost of charging a phone depends on location and ranges from KES10 ($0.09) to KES20 ($0.19).

On the other hand, it costs on average KES20 ($0.19) to charge a mobile phone at a community center[48] – with higher demand experienced in the evenings when the phone-charging kiosks are closed. Assuming that a phone is charged once every two days, most households (the majority of which own two phones) spend KES300 ($2.80) a month on charging alone if they use a phone-charging kiosk.

Thus, this expenditure on phone charging could be diverted into household electric power payments.

48 Community centers are common in the refugee camps. People use them to access services like television. The centers also have lighting for children to study at night.

4.5.2: Businesses

Businesses spend more than households on energy solutions, at an average of KES2,500 ($23) per month, with the highest spend noted in Kakuma camp and Kalobeyei town. Alternative solutions would thus have a better chance to succeed if they fit within this range.

Table 56: Average monthly amount businesses spend on energy solutions

	Total	Kakuma camp	Kalobeyei settlement	Kakuma town	Kalobeyei town
Sample size	85	52	11	6	16
Average spend per month on all energy needs (KES)	2,500	2,600	1,300	4,400	2,200

Note: All numbers are rounded to the nearest 100

Businesses in the study areas make an average monthly net income of about KES15,000 ($137) and spend about 16 percent of this on meeting their energy needs. As was observed with the households, businesses have unmet energy needs. They have electric devices that need powering. Most businesses have a mobile phone (87 percent). Twenty-six percent of businesses have a radio, 21 percent have a television, 20 percent have a refrigerator, 11 percent have security lights, and 8 percent have a computer or laptop, among the other kinds of appliance that need electrical power.

Most businesses (43 percent) reported that they charge phones at their business premises – where they have an SHS, solar lanterns, or a connection to power from private producers. About 25 percent of businesses charge their phones at home, 22 percent charge them at a phone-charging kiosk; 7 percent charge them at the house of a relative, friend, or neighbor; and 2 percent charge their phones at a friend's business premises. Those that charge their phones at a phone-charging kiosk pay KES10 ($0.10) per charge. Assuming that businesses use phones more frequently and need to charge them daily, this translates to an additional KES300 spent on energy each month.

5. Supply dynamics

05

This section focuses on energy sources for lighting and cooking. It maps out their current supply status and market size, and the challenges currently experienced by suppliers.

5.1: Solar lanterns

Supplier mapping

In the study areas, there are 18 distributors of solar lanterns. They sell around 299 lanterns a month and about 3,500 per year. Most of these traders are in Kakuma town.

Table 57: Number of solar lanterns sold by the 18 traders

Area	Brands	Number of lanterns sold
Kakuma town	Other brands	65
	Sun King	30
Kakuma camp 1	Other brands	6
Kakuma camp 3	d.light	13
	Other brands	87
	Sun King	8
Kalobeyei town	Other brands	5
	Sun King	4
Kalobeyei village 1	d.light	16
	Other brands	16
	Sun King	14
Kalobeyei village 3	Other brands	35
	Total	**299**

Market size

The price of solar lanterns varies from supplier to supplier, ranging from KES1,400 ($12.70) to KES3,850 ($35), as shown in Table 58. The main traders sell lanterns worth about KES778,750 ($7,094) per month, which translates to KES9,345,000 ($85,133) per year.

Table 58: Sales value of solar lanterns

Area	Brands	Number of lanterns sold	Average price per device (KES)	Average monthly sales (KES)
Kakuma town	Other brands	65	Varies	274,000
	Sun King	30	Varies	100,000
Kakuma camp 1	Other brands	6	Varies	21,050
Kakuma camp 3	d.light	13	3,850	50,050
	Other brands	87	1,450	85,100
	Sun King	8	2,350	18,800
Kalobeyei town	Other brands	5	5,350	26,750
	Sun King	4	2,850	11,400
Kalobeyei village 1	d.light	16	3,850	61,600
	Other brands	16	2,225	29,100
	Sun King	14	2,350	32,900
Kalobeyei village 3	Other brands	35	1,850	68,000
Total		**299**	**2,467**	**778,750**

From Table 58, it appears that well-established brands like Sun King and d.light sell at a higher price than other brands imported by individual traders, who then distribute them to other traders.

5.2: SHSs

Supplier mapping

Sun King, BBOXX, d.light, and Solar Panda are the main brands sold by companies supplying SHSs in the study areas. A few traders travel between Kakuma town and Kisumu[49] and sell SHSs of different output capacities. There are 20 traders dealing in SHSs and they sell and install about 200 SHSs in total in an average month. For example, d.light provides SHSs as well as solar lanterns. It sells the XA50 SHS, which has radiant heat, a torch, and five bulbs for lighting, with a full set providing 40 watts of power.

Market size

Demand for SHSs is not consistent month on month – though the smaller-capacity SHSs tend to be purchased more consistently throughout the year. The combined revenue from all traders is about KES2,692,500 ($25,182) per month on average, which equates to about KES32 million ($299,289) per year.

Table 59: Number of traders selling SHSs and average monthly sales

Area	Number of traders	Number of SHSs sold in an average month by all traders	Average monthly sales (KES)
Kakuma town	3	24	236,000
Kakuma camp 1	6	59	818,000
Kakuma camp 3	8	87	1,241,500
Kalobeyei village 1	3	31	397,000
Total	**20**	**201**	**2,692,500**

The capacity of a commonly sold SHS is 60 watts. A whole SHS system costs between KES9,000 ($82) and KES12,000 ($109), with the higher priced ones including the cost of transportation and installation. Some traders sell an 80-watt panel, which is preferred by businesses and is priced from KES19,500 ($177) to KES22,000 ($200), with the higher priced ones including the cost of installation and transport. SHS providers to the area make a profit of 20 percent to 30 percent of the product sales price.

Market challenges

The suppliers of SHSs face challenges in making these products locally available, as follows:

- **The cost of transportation is high**, due to the distance from their suppliers[50] and the fact that the systems are bulky. This increases the cost of the system, which inhibits sales.
- **Demand for SHSs is moderate**, higher among businesses than households and inconsistent month on month due to fluctuating income levels in the area. As a result, some suppliers are forced to diversify their product range.

49 This is about 577 kilometers away from Kakuma town.
50 It is 732 kilometers from Nairobi to Kakuma town, and a further 30 kilometers to Kalobeyei town.

- **Anticipated government regulation**. Currently, in order to start an enterprise, one only needs a business permit from the county government and access to technicians who can do the installation. This will change if a proposed regulation is approved. The government of Kenya, through the Energy and Petroleum Regulatory Authority (EPRA), is planning to regulate the sector through the draft Energy (Solar Photovoltaic Systems) Regulations (2020).[51] Under these proposed regulations, a person may not design, install, test, commission, maintain, or repair a solar PV system unless he is licensed by the relevant government authority.[52] As at November 2020, there were reportedly 700 licensed technicians and 1,080 registered solar PV companies in the country.[53] The draft regulations propose that EPRA may, on receipt of an application, grant the applicant one of four categories of license.[54] Each license has stringent qualifying criteria and there are not many technicians that would meet these requirements. To apply for a license, one needs to pay the application fee and take up indemnity insurance for one's business. Many technicians will not be able to afford these fees, thus limiting the number of licensed technicians available in the market.

5.3: Electricity from private electricity service providers

The section covers small-scale electricity providers operating in Kakuma camp and Renewvia, a mini-grid operator in Kalobeyei, regulated by EPRA.

5.3.1: Small-scale private electricity service providers in Kakuma camp

Supplier mapping

Refugee power producers generate electricity from diesel-based retrofitted engines typically used for tractors or power tillers. The power is distributed through substandard wiring to households and businesses. Due to the high cost of operating a diesel generator, the power supply is rationed daily in two intervals of four hours and two to three hours. This constrains the operations of businesses. Customers pay arbitrary tariffs as there are no metering systems. Furthermore, owners operate illegally, without the requisite EPRA permits to generate and supply electricity. This is partly due to applicants for such permits lacking the required legal documentation, such as a Kenyan identity card.

This study reviewed 19 providers in the refugee camps. Most of these are concentrated around Kakuma camp 1, Kakuma camp 3, and Kakuma camp 4. Kakuma camp 1 has seven private electricity service providers, camp 2 has two, camp 3 has six, and camp 4 has four.

As shown in Table 60, households pay a fixed monthly rate that ranges from KES1,140 ($10) in Kakuma 1 to KES1,917 ($17.50) in Kakuma 3, while business consumers pay between KES5,000 ($45) and KES7,000 ($64) depending on the number of electronic devices they need to power. Data is not available on the unregulated power producers' total power generation capacities in kilowatts or megawatts.

51 EPRA, Draft Energy (Solar Photovoltaic Systems) Regulations (2020), https://www.epra.go.ke/the-draft-energy-solar-photovoltaic-systems-regulations-2020/
52 Regulation 4(1), Draft Energy Solar Photovoltaic Systems Regulations (2020).
53 Macharia Kamau, State plans to police solar industry with tough rules, https://www.standardmedia.co.ke/business-news/article/2001395562/state-plans-to-police-solar-industry-with-tough-rules
54 Regulation 5, Draft Energy Solar Photovoltaic Systems Regulations (2020).

Table 60: Tariffs charged by private electricity service providers

	Unit requirement (watts)	Cost (KES)	Unit cost (kWh)
1 CFL bulb + phone-charging point	36	1,500	173.61
1 upright freezer	1,240	6,000	483.87
1 LCD television	150	3,500	97

Market challenges

- **Lack of capacity.** Generators assessed in Kakuma 1 are rudimentary, with low capacity to service the ever-increasing demand for power from the influx of refugees and growing number of small and medium businesses.
- **Unsafe generation and distribution practices.** The electricity distribution lines from the generators pose health and safety risks to businesses and households in the vicinity due to poor connections, as evidenced by the low-hanging and entangled wiring system. There is a constant threat of electrocution and fire that could easily spread in the crowded camp setting.[55]

5.3.2: Mini-grids in Kalobeyei

Renewvia, a private electricity service provider supported by GIZ, operates in Kalobeyei town and Kalobeyei villages 1 and 2. It supplies power to around 500 households and businesses in Kalobeyei village 1 and to institutional consumers in village 2. It plans to reach households and businesses in village 2 in due course. Renewvia runs a hybrid mini-grid that is predominantly solar powered, with diesel generators as backup if energy generated from solar is insufficient.

The company has a consumption-dependent pricing model, with a charge of KES20 ($0.20) per kilowatt-hour and a total fee based on total consumption per customer. There is a connection fee of KES537 ($5)[56] and most houses pay between KES200 ($2) and KES300 ($3) per month. Households mainly use this source of energy for charging phones and lighting.

In Kalobeyei village 3, a key informant from EPRA indicated that a company trading under the name of Yelele Limited had applied and been approved to supply electricity in the area. The company is installing a solar mini-grid to sell electricity to households and businesses in Kalobeyei settlement and host community, and has a smart-metering system that would allow users to only pay for power they consume.

Another supply-side actor is Okapi Green Energy, a Kakuma-based social enterprise that recently received international funding to expand a solar mini-grid to supply electricity for small businesses, community centers, and individual households. Okapi Energy intends to sell electricity to end users using smart meters, which would allow for charging consumption-based fees.[57]

Market challenges

A key informant indicated that a challenge facing companies such as Renewvia is the cost of labor, which is three to four times higher than in Nairobi. As a result, Renewvia has incurred higher operational and initial construction costs than anticipated. Although these have been subsidized by humanitarian partners and other investors, consumer prices are higher than those charged by KPLC.

55 Environmental Resources Management for IFC, Kakuma Kalobeyei Challenge Fund Strategic Environmental and Social Assessment, p. 51.
56 EPRA approved tariffs, and connection charges effective February 2020 were published in the Kenya Gazette notice 1254.
57 Smart Communities Coalition, 2019 Year in Review.

Table 61: Regulated power producers: Comparison of KPLC and Renewvia tariffs

KPLC			Renewvia	
Category	**Unit (kWh per month)**	**Tariff (KES/ kWh)**	**Category**	**Tariff (KES/ kWh)**
Domestic consumer 1[58]	0–100	10	Residential consumer	17.46
Domestic consumer 2[59]	101+	15.8		
Small commercial 1	0–100	10	Commercial consumer	21.83
Small commercial 2	101–15,000	15.6		

Renewvia is currently able to meet 30 percent of the market demand and is exploring ways to roll out its service to over 1,000 new customers, though many of its potential customers cannot afford the cost of connection and so may need a subsidy.

Current market size

Excluding Kalobeyei, where power provision is more structured (through regulated mini-grids),[60] the current 1,588 power connections in the Kakuma camps from various private electricity service providers generate revenue of about KES2,352,500 ($21,431) per month (see Table 62). This translates to KES28,230,000 ($257,174) per year.

58 Also called lifeline consumers. This is a volume-differentiated tariff category for household consumers connected to the national grid that consume between 0 and 100 kilowatt-hours per month based on a three-month moving average.
59 Also called domestic ordinary. This is a volume-differentiated tariff category for household consumers connected to the national grid that consume over 100 kilowatt-hours per month based on a three-month moving average.
60 Kalobeyei already has larger-scale private electricity service providers that can scale up their operations.

Table 62: Private electricity service providers and number of customers

	Number of players	Number of connections	Target customers	Total number of connections	Average charge per customer per month (KES)	Total revenue per month (KES)	Total revenue (KES)
Kakuma camp 1	7	654	Businesses	35	5,500	190,000	844,000
			Households	619	1,140	654,000	
Kakuma camp 2	2	170	Businesses	50	5,000	250,000	430,000
			Households	120	1,500	180,000	
Kakuma camp 3	6	691	Households	691	1,917	815,000	815,000
Kakuma camp 4	4	73	Businesses	28	7,000	196,000	263,500
			Households	45	1,500	67,500	
Kalobeyei town	1	130	Both	130	300*	Not known	Not known
Kalobeyei village 1	1	500	Both	500	300*	Not known	Not known
Kalobeyei village 2	1	-	Schools and administration areas only	-	Not known	Not known	
Kalobeyei village 3	1	-	Recently approved to supply electricity	-	N/A	N/A	N/A
Total		**2,218**		**2,218**	**-**	**2,352,500**	**2,352,500**

* This calculation uses the average amount that households pay per month – highlighting that there are some consumers that pay more than this.

5.4: Electricity from KPLC

KPLC is the national electric utility company that manages electric metering, licensing, and billing.[61] This public company is listed on the Nairobi Securities Exchange, with 50.1 percent shareholding by the Kenyan government and 49.9 percent shareholding by private investors.[62] In Kakuma, KPLC operates an electricity station powered by two diesel generators.

To get connected to KPLC, a customer is required to pay a connection fee, which is determined by the customer's distance from a transmission line, in addition to other fixed costs.

According to KPLC's website,[63] domestic customers (with a voltage load below 25 kVA) and premium applications (with voltage load above 25 kVA, excluding small and medium enterprises with a load between 100 kVA and 200 kVA) can apply for a power connection by visiting a KPLC branch. They can also apply through the KPLC self-service portal or by visiting a Huduma Centre.[64]

Generally, the application process involves a customer filling out an application form and providing:

- A copy of a national identity card or a copy of a passport if one is not a Kenyan citizen.
- A route sketch of the place where one wants the electricity supplied.
- Consent from the property owner if living in a rented home.
- Signed wiring certificates certifying that the building has properly installed wire connections.

These requirements are particularly difficult for refugee consumers to comply with as refugees face challenges acquiring identification documents.

The application requirements are the same for business customers, with the only difference being the attachment of copies of their business registration certificate and a personal identification number (PIN) certificate. Not many businesses in the study locations are registered and even when they are registered, not many have a PIN certificate, making it difficult to meet the registration requirements. However, sole proprietorships use the proprietor's ID, much like a household customer application.

In rural Kenya, which includes the Kakuma and Kalobeyei study areas, incentives apply under the Kenyan government's rural electrification initiative. These incentives aim to expand coverage of the national grid to an additional 500,000 households across the country. Under this program, beneficiaries are required to pay KES15,000 ($137) under a subsidized program supported by various donors to get connected (against the normal rate of between $318 and $447). Thus, in Kakuma, a KPLC connection costs KES15,000, with the approval process taking two to three weeks.

Market challenges

The primary challenges KPLC faces in obtaining more connections in the Kakuma-Kalobeyei area are:

- Money to finance the initial investment for connection.
- The fact that many households lack national ID cards and businesses may lack registration and PIN certificates necessary to apply for a connection.

61 Kenya Power, Corporate Profile, https://kplc.co.ke/img/full/VFMLsdlDFaoN_KENYA%20POWER%20OUR%20CORPORATE%20WORLD%2029%20March.pdf
62 Ibid.
63 Kenya Power, General Application Procedure, https://kplc.co.ke/content/item/793
64 A Huduma Centre is a government service center where one can apply for a national ID or register for services.

5.5: Firewood

Supplier mapping

There are about 42 large-scale firewood traders in the study locations, with most operating in the refugee camps.[65]

Table 63: Major firewood traders and average number of bundles sold per month

Location	Number of traders	Number of large bundles sold per month
Kakuma town	3	28
Kakuma camp 1	5	16
Kakuma camp 2	5	161
Kakuma camp 3	6	78
Kakuma camp 4	5	95
Kalobeyei town	2	11
Kalobeyei village 1	6	87
Kalobeyei village 2	6	60
Kalobeyei village 3	4	54
Total	**42**	**590**

Traders are mostly members of the host community who sell firewood to refugees. Their livelihoods, in addition to those of the small-scale traders who purchase from them, would be affected if alternative cooking fuels were adopted by consumers. Projects promoting alternative fuels or energy-efficient cookstoves should give consideration to initiatives that would equip these traders with skills to take up alternative income-generating activities.

Market size

A total of 590 large bundles[66] of firewood are sold per month (equivalent to about 5,900 of the small bundles shown in Figure 3). These firewood suppliers make a combined monthly revenue of around KES428,000 ($3,900), with 57 percent of revenue made in Kakuma camp, 38 percent in Kalobeyei settlement, 6 percent in Kakuma town, and 1 percent in Kalobeyei town. This is in line with previous findings that show that there is a higher preference for charcoal among Kakuma town residents and that residents of Kalobeyei town mostly collect their own firewood.

65 The team did not interview small-scale traders.
66 One large-sized bundle is then re-arranged into 10 bundles and sold at marketplaces or to consumers.

Table 64: Major firewood traders and their average monthly sales

Location	Number of traders	Number of large bundles sold per month	Average price of large bundle (KES)	Total sales of large bundle (KES)
Kakuma town	3	28	833	24,200
Kakuma camp 1	5	16	900	14,443
Kakuma camp 2	5	161	720	113,600
Kakuma camp 3	6	78	642	50,600
Kakuma camp 4	5	95	660	63,300
Kalobeyei town	2	11	500	5,350
Kalobeyei village 1	6	87	750	5,700
Kalobeyei village 2	6	60	775	47,100
Kalobeyei village 3	4	54	838	43,800
Total	**42**	**590**	**744**	**428,093**

In a year, this firewood is equivalent to about 7,080 large bundles (which equate to about 70,800 average-sized bundles resold to consumers), translating to KES5,137,116 ($46,798) annually.

The retail price of this firewood varies and is determined by the source of the wood, supply-and-demand dynamics such as higher prices when there is a shortage of firewood during the rainy season, and the type of wood. Longer-burning wood fetches a higher price.

Most refugee households reported obtaining firewood through their rations from Lotus Kenya Action for Development Organization (LOKADO), a local organization contracted by UNHCR to supply firewood to refugees. LOKADO was started in 2003 as a community-based organization involved in peace-building activities between refugees and host communities along the Kenyan borders. Firewood from LOKADO is harvested by host community members who are paid to collect it. These firewood rations reduce the need for refugee households to venture into the host community areas to harvest firewood, thus reducing conflict between these two groups. According to LOKADO, most of the wood it provides (95 percent) is sourced from the Prosopis Juliflora plant (thorny shrub). LOKADO has 14 harvesting locations within Turkana West and ensures that only 5 percent of the firewood is obtained from indigenous trees, while 95 percent comes from the thorny shrub. Firewood rations were phased out in 2021 in exchange for cash transfers.

Market challenges

Refugees receive 10 kilograms of firewood bundles as free rations, which are meant to last from two to three months. Refugee households, especially larger ones, feel that these rations are not adequate, as they do not last more than 10 days. A UNHCR representative in an interview acknowledged that the firewood supplied to the refugees is not always enough for households, but indicated that it would be expensive for humanitarian agencies to provide all the firewood required by a household and that this is not a sustainable solution. Therefore, to meet the firewood demand most refugees go outside the camps to fetch firewood to supplement whatever they obtain from UNHCR. This increases deforestation around the camps and exposes refugees to conflict with host community members and gender-based violence.

There is a need to reconsider the appropriateness of firewood as a major source of fuel for cooking by refugees because woodlands in the study areas are being degraded, and as such, the practice may not be sustainable. This shift would not be easy to implement, due to the entrenched habits of consumers and the reliance of host communities on income from firewood collection. As a representative of LOKADO indicated, even well-to-do households in the camps use firewood even when they can afford other, cleaner sources of energy for cooking.

Shifting to alternatives would require communication to promote behavioral change as well as providing energy sources for cooking that are affordable, cleaner, and sustainable. Another approach would be to reduce the amount of firewood used by households by improving the energy efficiency of cookstoves. Significantly, a transition away from firewood would result in income loss for the host community population, given that firewood sales are one of their most important sources of income.

5.6: Charcoal

Supplier mapping

The study team identified and obtained information from the main charcoal suppliers in the study locations. These suppliers supply smaller retail traders.[67] Kakuma town has the highest number of charcoal traders, which is in line with the data on higher charcoal use by town residents compared with other locations.

Table 65: Number of large charcoal traders and amount of charcoal sold

Location	Number of providers	Number of sacks sold
Kakuma town	15	420
Kakuma camp 1	2	30
Kakuma camp 2	6	124
Kakuma camp 3	4	37
Kakuma camp 4	1	40
Kalobeyei town	2	5
Kalobeyei village 1	14	179
Kalobeyei village 2	4	76
Kalobeyei village 3	7	28
Total	**55**	**1,039**

Market size

The charcoal traders sell charcoal in 45 kilogram sacks for between KES650 ($6) and KES750 ($6.80). The price varies from one location to another, as shown in Table 66. The price of charcoal varies between the dry and the rainy seasons, with the product being more expensive during the rainy season.

67 Small-scale resellers that package their charcoal in *debes* and sell it to households often purchase their stock from these large-scale traders. Thus, using estimates obtained from the large traders would capture the amount of charcoal sold by the small-scale traders.

Table 66: Number of large charcoal traders and average monthly sales

Location	Number of sacks sold	Average price per sack (KES)	Total monthly sales (KES)
Kakuma town	420	687	285,500
Kakuma camp 1	30	650	19,500
Kakuma camp 2	124	708	84,050
Kakuma camp 3	37	750	27,400
Kakuma camp 4	40	650	26,000
Kalobeyei town	5	650	3,300
Kalobeyei village 1	179	650	114,100
Kalobeyei village 2	76	650	51,400
Kalobeyei village 3	28	707	96,350
Total	**1,039**		**707,600**

The charcoal sold by these traders amounts to total monthly sales of KES707,600 ($6,446), which translates to KES8,491,200 ($77,354) per year. The revenue split among locations is as follows: 40 percent in Kakuma town, 37 percent in Kalobeyei settlement, 22 percent in Kakuma camp, and less than 1 percent in Kalobeyei town. This is in line with previous findings showing a higher dependence on charcoal among Kakuma town residents and a relatively lower percentage of Kalobeyei town residents using charcoal compared with the other locations.

Market challenges

- Due to the poor state of the roads and the distances covered to obtain charcoal stocks, the traders incur high transport costs. These costs are added to the price of the charcoal, which makes charcoal an expensive commodity for some households.
- The traders also struggle to meet demand due to the destruction of forest reserves. While they admit that they benefit from this destruction of the environment, they acknowledge that their trade will not be sustainable in the future.

Energy-efficient cookstove production

A key informant from SNV suggested that a solution to the market challenges might be to engage the charcoal sellers in selling alternative cooking fuels and solutions. One of these solutions would be energy-saving charcoal cookstoves. This informant noted that there are several local initiatives aimed at encouraging the use of energy-efficient charcoal cookstoves in the study areas.

An example of this is SNV's partnership with KWEO Enterprises, a social enterprise run by a women's group from Kisumu that makes artisan energy-saving cookstoves for resale. This partnership has been increasing the availability of energy-saving charcoal cookstoves in the study locations and is now seeking to work with local communities to create a small local industry that makes and distributes these cookstoves. Towards this end, SNV is training local communities to produce them and is providing the machines required for production.

So far, SNV has observed refugees embracing the energy-saving charcoal cookstoves and has sold over 3,000 units in their first year of operation. They plan to sell at least 1,500 more stoves year on year. They noted that the demand in the camp is beyond their current production capacity and that they are therefore exploring means to increase production. There is thus market potential to expand the availability of energy-saving cookstoves.

5.7: LPG

Supplier mapping

In the study areas, there are only four traders who distribute LPG cylinders and cookers. These are all based in Kakuma town. All sell the 6 kilogram LPG cylinder, and two traders also sell the 13 kilogram cylinder. While household consumers indicated that they have 3 kilogram cylinders, no trader was found refilling these at the time of data collection, and as such, households were keeping empty cylinders.[68]

Market size

On average, 288 cylinders are sold in a month – comprising 258 refills and new sales for the 6 kilogram cylinder. Refills of the 6 kilogram cylinder sell for between KES1,200 ($11) and KES1,500 ($13.6), as shown in Table 67. Only about 30 refills and new sales are sold in a month for the 13 kilogram cylinder, and these sell for between KES3,000 ($27) and KES 3,300 ($30) per refill.

Table 67: Number of LPG traders and their monthly sales

Trader ID	Location	Cylinder capacity	Number sold	Selling price (KES)	Total sales per month (KES)
LPG1	Kakuma town	6 kg	8	1,500	12,000
LPG2	Kakuma town	6 kg	100	1,300	130,000
LPG3	Kakuma town	6 kg	100	1,200	120,000
LPG3	Kakuma town	13 kg	20	3,000	60,000
LPG4	Kakuma town	6 kg	50	1,500	75,000
		13 kg	10	3,300	33,000
Total sales			**288**		**430,000**

Each month, the suppliers sell gas refills totaling KES430,000 ($3,917), which translates to an average of KES5,160,000 ($47,007) per year. This is a considerable amount given that only 4 percent of households and three out of the 14 catering establishments interviewed reported using LPG for cooking.

There is potential to expand the reach of LPG to the refugee camps, although this might require donors to shift from providing firewood rations to providing cash. This would allow refugees to choose their preferred energy source.

68 Fieldwork teams indicated that households have the cylinders but do not use them since they are not able to obtain refills locally. Over time, due to demand and supply challenges, many gas refill retailers have stocked the 6 kilogram and 13 kilogram cylinders, which sell faster. Desk research shows that these 3 kilogram cylinders were introduced in 2011 by the National Oil Corporation of Kenya and distributed to many parts of the country. Other oil marketers started producing the same. These cylinders were targeted at poor households to address the issue of affordability. However, the distribution model needs to be reviewed, as uptake has not been sustained.

Market challenges

- **Transportation costs.** The pre-filled gas cylinders are usually obtained from Eldoret,[69] and transported by road to Kakuma town. Due to the distance and poor road conditions, high transport costs are incurred. This cost is passed on to consumers.
- **Quality issues.** To reduce transport costs, the traders place joint orders and hire a vehicle and driver to fetch their supplies. This saves on costs but means that they are not able to ascertain the quantity of gas in the cylinders and sometimes get supplied with LPG cylinders that are not properly filled.

5.8: Generators

In the study areas, only one trader of generators was found. This trader is based in Kakuma town and sells about four generators in a good month. The trader declined to share information on his average monthly sales, though the field team observed that he had generators with different output capacities.

Market challenges

- Uptake is rather low because not many customers can afford a generator.
- Transporting generators from their source, often Kisumu town (which is about 577 kilometers away) or Nairobi (which is 732 kilometers away) further increases the selling price.
- Installation requires experienced technicians, who are not readily available.
- Generators also run on diesel and petrol, with shortages experienced from time to time.

69 Which is about 484.4 kilometers away.

06

6. Strategic context and regulatory framework

6.1: Strategic context

Energy is a key enabler of Kenya's development, as outlined in Kenya Vision 2030 and the Big 4 Agenda. The Big 4 Agenda is a flagship project of the current president that targets four priority areas for Kenya: ensure food security, avail affordable housing, expand manufacturing opportunities, and provide affordable health care to all citizens.

To realize the Agenda, the government has committed to investing in energy generation, transmission, and distribution; petroleum supply and storage; geothermal steam exploration; and distribution of gas cylinders.[70] The Big 4 Agenda aligns with the development plan set out in Kenya Vision 2030, Kenya's main strategy document for development.[71]

Recognizing the importance of the energy sector to the country's development, Kenya Vision 2030 recommends implementing initiatives to increase energy production and distribution.[72] This strategy is being implemented through the Third Medium Term Plan 2018–2022, which includes energy initiatives.

Various national and county government initiatives that drive the energy sector are discussed below.

70 The Big 4 Agenda, https://www.delivery.go.ke/flagship
71 Ibid.
72 Kenya Vision 2030, http://vision2030.go.ke/publication/kenya-vision-2030-popular-version/

6.2: Initiatives by the national government

The national government has in place several initiatives to expand the energy sector in Kenya. In implementing these initiatives, the national government is guided by a framework of legislation, regulations, and strategy documents enacted to support the sector's growth.

6.2.1: The Energy Act and subsidiary legislation under it

The Energy Act (2019)[73] provides the main regulatory framework for energy in Kenya. It establishes national and county government functions to provide for the establishment, powers, and functions of the energy sector entities. It also provides for the promotion of renewable energy; exploration, recovery, and commercial use of geothermal energy; regulation of midstream and downstream petroleum and coal activities; and regulation, production, supply, and use of electricity and other energy forms.

The act acknowledges that the government must facilitate the provision of affordable energy services to everyone in Kenya.[74] It provides that where the national or county government determines that an area requires an energy supply, the government shall supply the energy itself or provide the funds necessary to develop such works if the area is assessed

73 Energy Act, No. 1 of 2019, https://kplc.co.ke/img/full/08wccHsFPaZ3_ENERGY%20ACT%202019.pdf
74 Section 7(1), Energy Act.

to be commercially inexpedient for a licensee to provide the reticulation.[75] This is in line with the government's target of ensuring that all households are connected to a supply of electricity by 2030.[76]

The Energy Act establishes national energy sector entities such as the Energy and Petroleum Regulatory Authority,[77] which is mandated under section 10 to oversee the generation, importation, exportation, transmission, distribution, supply, exploration, and use of various forms of electrical energy, including renewable energy, non-renewable energy, and petroleum energy.

The act also established the Energy and Petroleum Tribunal,[78] to hear and determine disputes and appeals arising from this sector, and the Rural Electrification and Renewable Energy Corporation,[79] to oversee rural electrification in Kenya. The corporation is spearheading Kenya's green energy drive, in addition to implementing rural electrification projects.[80] It is also driving the government's electrification initiatives in Kakuma and Kalobeyei.

The Energy Act mandates the Cabinet Secretary to develop and publish a national energy policy in consultation with stakeholders that is reviewed every five years.[81] In line with this mandate, the Ministry of Energy has in place the National Energy Policy (October 2018),[82] which seeks to ensure a sustainable, adequate, affordable, competitive, secure, and reliable supply of energy at the least cost geared to meet national and county needs while protecting the environment.[83]

From this policy, it is evident that Kenya intends to become a major producer and exporter of renewable energy (geothermal, solar, and wind).[84] Through the Least Cost Power Development Plan, the government intends to generate 300 megawatts of wind power from Lake Turkana.[85] However, it is unclear to what extent this plan has been implemented to date.

Another policy established by the Ministry of Energy is the Kenya National Electrification Strategy. Its principal objective is to establish an approach to achieve electricity access for all households and businesses in Kenya over the shortest time possible and at an acceptable quality of service.[86] The strategy supports the scale-up of off-grid service for rural and remote areas[87] and plans to help establish new mini-grids for 34,700 households outside the reach of the KPLC grid,[88] although it does not state where these mini-grids will be located.

The Energy Act gives the national government the authority to exploit renewable energy sources, including solar power.[89] As such, the Ministry of Energy is tasked with promoting the development and use of renewable energy technologies, such as solar solutions, hydropower, biodiesel, and bioethanol.[90]

Relevant provisions under the Energy Act that are important for this report are outlined in the following subsections.

The power to carry out generation, exportation, importation, transmission, distribution, and retail supply of electricity

According to section 117 of the Energy Act, a person wishing to generate, export, import, transmit, distribute, and sell electricity must apply to EPRA for a license. This applies to anyone, including households, generating energy of more than 1 megawatt. Those who fail to acquire a license are liable to a fine of at least KES1 million or a term of imprisonment of at least one year, or both.

75 Section 7(2), Energy Act.
76 Section 7(3), Energy Act.
77 Section 9, Energy Act.
78 Section 25, Energy Act.
79 Section 43, Energy Act.
80 https://www.rerec.co.ke/
81 Section 4(1), Energy Act.
82 National Energy Policy (October 2018), https://kplc.co.ke/img/full/BL4PdOqKtxFT_National%20Energy%20Policy%20October%20%202018.pdf
83 Ibid.
84 Ibid.
85 Updated Least Cost Power Development Plan 2011 to 2031, https://www.renewableenergy.go.ke/downloads/studies/LCPDP-2011-2030-Study.pdf
86 Kenya National Electrification Strategy, http://pubdocs.worldbank.org/en/413001554284496731/Kenya-National-Electrification-Strategy-KNES-Key-Highlights-2018.pdf
87 Ibid.
88 Ibid.
89 Section 73, Energy Act.
90 Section 75, Energy Act.

Under section 117(3), an applicant must give 15 days' notice, by public advertisement in at least two national newspapers, before applying for a license. The notice must state that anyone wishing to make a representation on or object to the application or the granting of the license must do so by letter to EPRA (with "Electric Power Licence Objection" marked on the envelope) within 30 days from the date of the application as stated in the notice. The notice must also state that a copy of the representation or objection must be forwarded to the applicant. Within 15 days of receiving the application, EPRA must inform the applicant in writing whether the application is complete.

In granting or rejecting an application for a license, EPRA must consider the following:[91]

- The impact of the undertaking on the social, cultural, or recreational life of the community.
- The need to protect the environment and to conserve the natural resources in accordance with the Environmental Management and Coordination Act (2012).
- Land use or the location of the undertaking.
- Economic and financial benefits to the country or area of supply of the undertaking.
- The economic and energy policies in place.
- That the contractual rights, privileges, liabilities, and obligations accrued to an existing licensee or any other person are not materially adversely affected.
- The cost of the undertaking and financing arrangements.
- The ability of the applicant to operate in a manner designed to protect the health and safety of its employees and users of the service for which the license is required and other members of the public who would be affected by the undertaking.
- The technical and financial capacity of the applicant to render the service for which the license is required.
- Any representations or objections made under section 120.
- The applicant's proposed tariff.

91 Section 121, Energy Act.

Types of licenses granted under the Energy Act

EPRA issues the following licenses under the Energy Act: power generation license, transmission license, distribution license, and electrical contractor license.

A power generation license

This is provided for under section 132 of the Energy Act. A generation license authorizes the licensee to operate the generating station or plant stated in the license and connect to a distribution or transmission network.[92] Licensees must submit technical details regarding their generating stations to EPRA to obtain the license.[93] Information about the application cost for this license is not publicly available, and a potential applicant would need to check with EPRA.

A transmission license

This is provided for under section 135 of the Energy Act. This license authorizes a licensee to operate the transmission network stated in the license and connect it to another transmission or distribution network within or outside Kenya. The transmission licensee is expected to build, maintain, and operate an efficient, coordinated, and economical transmission system.[94]

They are also expected to provide non-discriminatory open access to their transmission system for use by any licensee or eligible consumer on payment of a fair transmission or wheeling charge.[95] This provision anticipates the sharing of transmission infrastructure among licensees in an area. Information about the application cost for this license is not publicly available, and a potential applicant would need to check with EPRA.

A distribution license

This is provided for under section 139 of the Energy Act. This license authorizes the licensee to plan, build, operate, and maintain a distribution system that conveys electrical energy from generating stations or plants, either directly or through the transmission

92 Section 135, Energy Act.
93 Section 132(3), Energy Act.
94 Section 136, Energy Act.
95 Section 136(1)(c), Energy Act.

system, to consumers. This means that a local power generator will also need to obtain this license for distribution on their electric supply lines or those built by Kenya Power or the county governments. Information about the application cost for this license is not publicly available, and a potential applicant would need to check with EPRA.

It is worth noting that any person wishing to generate, transmit, distribute, or supply power needs to do so in compliance with the Energy (Electricity Licensing) Regulations (2012),[96] in addition to the provisions of the Energy Act. People wishing to distribute and transmit power need to do so in compliance with the Kenya National Distribution Grid Code[97] and the Kenya National Transmission Grid Code.[98]

An electrical contractor license

This is provided for under section 148(2) of the Energy Act. A person who wishes to carry out electrical installation work must be licensed as an electrical contractor by EPRA[99] and registered by the Electricity Regulatory Board as an electrical contractor.[100]

To obtain a license, the applicant must be a certified electrical worker or employ a certified electrical worker. The electrical contractor license application is processed in 60 days from the date of application and the applicant may be required to take tests. The license is valid for three years and may be renewed on expiry, subject to the holder providing evidence that they have undertaken continuing technical training. Applicants can apply for the license online, through the EPRA website.[101]

There are five classes of license for electrical workers and contractors. The application fees for these licenses range from $250 to $1,000. See Appendix 9.2 for more information.

96 EPRA, Energy Electricity Licensing Regulations, https://www.epra.go.ke/download/the-energy-electricity-licensingregulations-2012/
97 EPRA, Kenya National Distribution Grid Code, https://www.epra.go.ke/download/kenya-national-distribution-grid-code/
98 EPRA, Kenya National Transmission Grid Code, https://www.epra.go.ke/download/kenya-national-transmission-grid-code/
99 Section 148 and 149, Energy Act.
100 Regulation 7(1), Electric Power (Electrical Installation Work) Rules (2006).

Restrictions on the licenses obtained from EPRA

Once a licensee obtains a license, they may not transfer or divest any rights, powers, or obligations conferred or imposed on them by the license without EPRA's consent.[102]

The application process to transfer one's license rights is outlined in section 124(2)(e) of the Energy Act. EPRA can also transfer the license to other people in the following circumstances:[103]

- In the case of the licensee's death, to the legal representative of such licensee.
- In the case of bankruptcy of the licensee or assignment for the benefit of their creditors generally, to the lawfully appointed trustee or assignee.
- In the case of a corporation in liquidation, to the lawfully appointed liquidator.
- In any case where the licensee becomes subject to a legal disability, to any person lawfully appointed to administer the licensee's affairs.

EPRA maintains a register of licensees, including modifications made to licenses, making it possible to trace the history of a license.[104]

Regulations on setting up energy infrastructure

Section 170 of the Energy Act provides that a person may develop energy infrastructure, including electric supply lines, petroleum or gas pipelines, and geothermal or coal infrastructure, on, through, over, or under any public, community, or private land subject to the provisions of all relevant written law. The person must seek the prior consent of the landowner. If the owner of the land cannot be traced, the applicant must give 15 days' notice through public advertisements in at least two national newspapers and on a local radio station for two weeks.

101 Energy Regulatory Commission, ERC Application Portal, https://portal.erc.go.ke:8443/site/login
102 Section 124, Energy Act.
103 Section 121(2), Energy Act.
104 Section 128, Energy Act.

Requirements for metering connections

Section 154 of the Energy Act requires that the amount of electricity supplied to the consumer, the number of hours during which the supply is given, the maximum demand taken by the consumer, or any other quantity or time connected with the supply must be ascertained by meters of a type approved by the Kenya Bureau of Standards, or determined in a manner agreed on by the retailer and the consumer. The retailer must supply and install a meter on the consumer's premises and connect it to the supply system. Instead of a meter installed by the provider, a licensee may agree to the value of the supply being determined by a private meter belonging to the consumer. In such a situation, the licensee is expected to seal the meter with an approved seal bearing their distinguished brand or mark.

Under section 158, the provider may not connect or disconnect a meter or a consumer's check meter unless the licensee has obtained the consumer's written consent or given the consumer at least 48 hours' written notice of their intention to do so. Similarly, the provider is not allowed to make any alteration, adjustment, or readjustment to a meter that affects the functioning of the meter unless the licensee has given the consumer at least 48 hours' written notice of their intention to do so or unless otherwise mutually arranged. Failure to do so exposes the provider to a fine of at least KES100,000, a term of imprisonment of at least six months, or both.

Where a meter is found to be defective through no fault of the provider or the consumer, the provider may, in consultation with the consumer, determine a reasonable quantity of electrical energy supplied and recalculate the charges due to or from the consumer as appropriate for up to six months from the date the meter is confirmed to be defective.[105]

Power tariff structure and terms

Section 11(b) of the Energy Act states that EPRA must set, review, and adjust electric power tariffs and tariff structures and investigate tariff charges, regardless of whether an application has been made for a tariff adjustment. Section 165 of the Energy Act provides that the tariff structure and terms for the supply of electricity to consumers must be in accordance with principles prescribed by EPRA. One principle is that all tariffs must be just and reasonable.

To apply for approval of tariffs, one must complete and submit an application form for EPRA's approval not later than 45 days before the proposed effective date.[106] EPRA provides approved charge rates to power generators and suppliers, which are informed by factors listed on EPRA's website.[107]

The Standard Tariff Application Model for Mini-Grids is to be used for all mini-grid tariff applications to EPRA. It incorporates various factors to calculate a tariff, such as capital costs, tariff inputs, loan drawdown considerations, load profile by customer class, customer metering, and account costs, among the standard energy levies. EPRA reviews this retail tariff every three years.[108]

Complaints and dispute resolution process

Complaints about the licensing process can be made, as provided under the 2012 Energy (Complaints and Disputes Resolution) Regulations, which applies to any person wishing to make a complaint or raise a dispute regarding any license, permit, contract, code, conduct, practice, or operation of any party regulated under the Energy Act. Complaints or disputes are made to the Energy Regulatory Commission.

Once the Energy Regulatory Commission makes a decision on a dispute, one can appeal the decision to the Energy and Petroleum Tribunal,[109] which hears and determines appeals from private electricity service providers, oil marketing companies, and the general public.

105 Section 159(1), Energy Act.

106 Section 165(3), Energy Act.

107 EPRA, Standard Tariff Application Model for Mini-Grids, https://www.epra.go.ke/services/standard-tariff-application-model-for-minigrids/

108 Section 165(7), Energy Act.

109 Kenya Law, Know your tribunals, http://kenyalaw.org/kl/index.php?id=9050

6.2.2: Draft Energy (Solar Photovoltaic System) Regulations (2020)

There are discussions around the draft Energy (Solar Photovoltaic System) Regulations (2020), which will regulate the solar sector. These regulations have proposed stringent requirements to be licensed as a technician or contractor of solar systems. First, a person will need to have a license for the installation they seek to provide technical work for.

The minimum academic qualification requirements and the fees charged will make some categories of technicians scarce and thus expensive to hire due to decreased competition.

Another proposed regulation prohibits a person from importing, manufacturing, selling, or installing solar PV systems or their components without a valid license issued by EPRA.[110]

This stringent regulation will reduce competition for products and spare parts initially, which will in turn result in increased prices for SHS units and their spare parts.

People engaged in importing, manufacturing, selling, or installing solar PV systems or their components will be licensed under one of five license categories, as shown in Table 87 in Appendix 9.3.[111] Each of these license categories places restrictions on what one is allowed to do. Details of these restrictions are summarized in Table 88.

These regulations may limit the number of technicians able to install solar power equipment in the future if technicians are not trained to meet these requirements.

110 Regulation 7(1), Draft Energy Solar (Photovoltaic System) Regulations (2020).
111 Regulation 8, Draft Energy Solar (Photovoltaic System) Regulations (2020).

6.3: Initiatives by the Turkana County Government, IFC, and donor partners

Through the 2016–2020 County Investment Plan, the Turkana County Government, which is the local government responsible for the study locations, ran a program to expand energy access. The program aimed to connect 200,000 households to electricity by 2020.[112]

The Turkana County Government managed to provide power to several public institutions (boarding schools, health centers, and dispensaries) through solar electricity generators where there was no immediate access to infrastructure.[113]

In support of this program, various donor partners worked with the county government to improve access to electricity. A few notable projects that have been running in the study locations under the 2016–2020 County Investment Plan include the following:

- The Energizing Development's (EnDev's) results-based financing facility for mini-grids project (July 2014 – December 2019). This project was co-implemented by GIZ and Barclays Bank of Kenya with funding from the United Kingdom's Foreign, Commonwealth and Development Office.[114] It provided subsidies to private sector investors to develop solar PV hybrid mini-grids in Marsabit and Turkana counties. The subsidies were capped at 50 percent of the capital expenditure, except for the mini-grids in Kalobeyei refugee settlement and the host community town, where the subsidy was 82 percent to achieve national utility tariff rates.[115]

112 Turkana County Government – County Investment Plan 2016–2020, https://turkana.go.ke/wp-content/uploads/2016/11/TURKANA-COUNTY-INVESTMENT-PLAN-1.pdf
113 Turkana County Government – County Investment Plan 2016–2020, https://turkana.go.ke/wp-content/uploads/2016/11/TURKANA-COUNTY-INVESTMENT-PLAN-1.pdf
114 Formerly Department for International Development (DFID).
115 EnDev's RBF facility for mini-grids: Experience from Kenya and Rwanda, https://minigrids.org/wp-content/uploads/2019/07/RBF_Mini-grids_Implementation_Kenya-Rwanda.pdf

- The OVO Foundation (Project Jua), in partnership with Energy 4 Impact, has been working to electrify schools and clinics in the least developed counties of Kenya. The pilot phase implemented in 2017 included six 800 watt solar installations at schools and clinics in Kakuma.
- SNV, with support from EnDev, implemented a market-based energy-access intervention for refugees and host communities in Kakuma camp and Kalobeyei settlement in 2018. The intervention aimed to promote sustainable market-based energy access for cooking and lighting by supporting energy entrepreneurs. SNV facilitated sales of SHSs from four solar companies: Azuri, Greenlight Planet, Pawame, and Sollatek.
- BBOXX's Solar Home System Supply Chain Support Project aimed to increase distribution of high-quality solar products in and around Kakuma refugee camp. The Moving Energy Initiative (MEI) provided BBOXX with a grant of just over £30,000 to de-risk the firm's investment in a retail outlet for its products and in testing the market for SHSs. The MEI grant covered the acquisition of 75 SHS units, rent, and staff costs for an initial six-month period, associated training costs, and marketing materials. The MEI also helped BBOXX with marketing activities such as roadshows and radio advertising. BBOXX launched its retail shop in Kakuma town in February 2018 and sold all 75 units within the first four months. About 66 units were sold to residents within the refugee camp. In total, BBOXX sold 104 SHS units within the first six months, including an additional 40 units financed by the firm.[116] According to the 2018 study report for the Smart Communities Coalition – Make Change Pilot, the SHS units are sold on a pay-as-you-go basis, following an initial down payment, with payments made through mobile money. As of June 2018, BBOXX had not had any payment defaults, and it reported that customers were requesting SHS options that include televisions and one-off payment plans as opposed to pay-as-you-go. Current challenges include high transportation and labor costs, and climate conditions that negatively affect solar installations.[117]
- Solar Electrification – International Rescue Committee (IRC) Clinics 5 and 6.[118] This MEI project aimed to incentivize private sector engagement in the provision of sustainable energy solutions, including through strategic partnerships with humanitarian actors, and to promote local market development and commercial business models. In 2018, the MEI funded the installation of solar systems at two IRC-run clinics – clinics 5 (3 kW) and 6 (36 kW) – within Kakuma camp. The installation was done by Kube Energy, working with PowerGen. Kube Energy trained IRC staff, as well as 15 skilled and non-skilled people from the host and refugee communities to support the installation, operation, and maintenance of the solar systems. The IRC managed the systems and signed an initial one-year operational and maintenance contract with PowerGen.

In addition to these projects run in close collaboration with the county government, other projects that support different energy solutions have been implemented in the county. The most notable projects include the following:[119]

- EDP Kakuma Street Lighting Project (2010–2013): Through this project, the Portuguese company EDP distributed 4,500 rechargeable solar lanterns (for free) and installed 31 streetlights (including 10 in the host community) and institutional solar systems of 1–3 kW in Kakuma. However, operational and maintenance funding ran out and most institutions have gone back to using diesel or have no power anymore.
- IKEA Foundation – Brighter Lives for Refugees Campaign (2016–2018): The project aimed to distribute free solar lanterns to 36,000 households in Kakuma, install about 350 solar streetlights in Kalobeyei settlement around public facilities and the trading center, and install 900 solar streetlights in Kakuma camp including around the airstrip.

116 Moving Energy Initiative, https://www.chathamhouse.org/sites/default/files/2019-02-2019-InnovativeFinancingforHumanitarianEnergy.pdf

117 Smart Communities Coalition – Make Change Pilot, March 2019, p.18, https://energy4impact.org/file/2087/download?token=BsWZzcRf

118 A 2018 study report for the Smart Communities Coalition – Make Change Pilot, https://www.energy4impact.org/file/2087/download?token=BsWZzcRf

119 Ibid.

The Turkana County Government is in the process of rolling out the Turkana County Energy Sector Plan for 2020 to 2025. This strategy document sets out the following energy-related goals for the county:

- Increase access to electricity and modern lighting from 14.8 percent of the population to 30 percent. Support the Energy Access Scale-Up Programme through which 200,000 households will be connected to electricity over a five-year period.
- Provide power to public institutions (boarding schools, health centers, and dispensaries) through solar electricity generators where there is no immediate access to infrastructure.
- Become a major producer and exporter of renewable energy (geothermal, solar, and wind).
- Install solar PV in 450 public institutions.
- Install biomass cookstoves in 70 institutions.
- Install solar streetlights in 20 towns.

The Turkana County Government has prioritized addressing the needs of Kakuma town, one of the county's main urban centers, so it is likely that some of these goals will be realized in the study locations.

The Turkana County Energy Sector Plan for 2020 to 2025 identifies poor transmission and distribution infrastructure, the high cost of power, low per capita power consumption, and low countywide electricity access as the main challenges facing the power sector in the county. The county government is willing to work with the private sector to address these challenges, so that it can attract and encourage private sector investment in energy, including setting up mini-grids and extending the grid where possible.

In line with this goal, it has identified KKCF as one of the programs that will help drive this growth in energy access in both Kakuma and Kalobeyei.

KKCF has thus far awarded grants to three renewable energy companies to start or expand operations in the Kakuma-Kalobeyei area.

- **Sunken**. The company manufactures energy-saving stoves in Turkana. It runs the only production plant in the county and supplies the products to entrepreneurs in Kakuma and Kalobeyei. With the grant, it intends to increase its stove production capacity and establish four distribution hubs in Kakuma camp.
- **Renewvia**. The company intends to expand its mini-grid capacity and existing customer connections in the Kalobeyei settlement area. The project aims to connect 2,250 new clients to the mini-grid.
- **Green Innovation Ventures Enterprises Limited**. The company deploys clean energy in Homa Bay, Migori, and Turkana County, among others. It sets up mini-grids, sells solar home systems, and installs customized solar power systems and cold chain solutions. With the grant, the company will deliver energy and appliances for productive use to at least 200 businesses in Kakuma and Kalobeyei by 2025.

07

7. Potential solutions and business models

This chapter highlights a number of proposed business models and technical solutions to improve access to clean energy.

7.1: Energy for cooking

7.1.1: Energy-saving cookstoves

There is an opportunity to support initiatives that expand the use of energy-saving stoves since it will be challenging for households to shift immediately from using firewood and charcoal. To cut the high transportation cost for stoves being sourced from Nairobi or Kisumu, local groups or enterprises can be supported to produce stoves, thereby saving fuel costs and reducing emissions and the environmental impact of current manufacturing practices.

Such an initiative would also serve to empower the local communities by providing them with a source of livelihood that could partly make up for any reduction in income from reduced firewood sales. Under the initiative, different varieties of stoves could be made to support cooking with either firewood or charcoal.

Figure 6 illustrates an approach for the suggested model.

Figure 6: Proposed community-driven model to locally produce energy-efficient stoves

Partner with organizations involved in supporting the production of energy-efficient cookstoves.

- These organizations would train local community groups in both technical and financial skills.
- They would also provide these groups with technical support on various sources of raw materials.
- They would guide community-based organizations (CBOs) on the standards to follow.
- They would make available machines needed to support production.
- They would advise on the link to markets for the finished products

Link CBOs to funding alternatives.

- Such a venture would require capital investment. One source would be member contributions. In addition, CBOs could be trained on financial management to help them manage their expenditures and re-invest some of their profit back into the business to support expansion.
- Link women-affiliated groups to the Women Enterprise Fund.
- Link youth groups to the Youth Enterprise Development Fund.
- Link CBOs to grants and technical support from donor partners.

In supporting such initiatives, any market actor would need to conduct a cost-benefit analysis to ensure that the stoves will provide sufficient revenue while remaining affordable for consumers.

Humanitarian organizations and private partners could train and support groups to apply for funding under the government's Women Enterprise Fund or the Youth Enterprise Development Fund. They could also provide groups with a seed grant or loan to begin operations.

The expectation is that in the initial years the demand for these products would be targeted at meeting local needs, and over time, sales activities would be expanded to other regions.

Table 68: Potential risks and challenges associated with a community-based model to locally produce energy-efficient stoves

Challenge/Risk	Anticipated mitigation measures
Poor-quality and non-durable cookstoves would not be adopted by consumers, so revenues would be insufficient. If consumers find that the energy-saving stoves are not durable, they will stop using them and advocate against them.	Ensure groups are set up and trained to produce stoves to minimum quality standards. The following will be needed: • Standards of production. • Quality assurance mechanism and branding for quality-assured and verified stoves.
Production materials may not be locally available, thereby increasing transport costs for their sourcing.	Explore a bulk buying and transportation approach for the raw materials required so that community groups can benefit from economies of scale.
Counterfeiting of the quality-assured energy-saving stoves.	Develop or adopt a quality stamp to prevent counterfeiting.
Loss of income from firewood and charcoal would negatively affect host communities.	While this cannot be fully prevented, it is important to ensure that those who are currently benefiting from firewood and charcoal sales are the initial beneficiaries of the cookstove business. In addition, alternative income-generating activities should be considered because collecting firewood is not a sustainable activity in the area.

7.1.2: Support initiatives to help households and businesses acquire LPG

Given that LPG is the preferred cooking fuel, there is an opportunity to expand its use in the area. It is recommended that KKCF explore partnering with one of the large fuel distribution companies to extend the scope of their operations in LPG to the Kakuma and Kalobeyei areas. This would address the issue of regulating the quantity of gas refilled into the cylinders to the required amount as well as meeting latent demand. There is potential for a credit purchase program or a saving program that helps consumers meet the initial cost of acquiring an LPG cylinder, a burner, and gas. Alternatively, the initial cost of obtaining an LPG cylinder and cooker could be subsidized. Figure 7 presents a possible model.

Figure 7: Proposed partnership model for LPG distribution

Partner with major fuel distribution companies and subsidize the initial cost of acquiring an LPG cylinder and cooker.

- Engage a fuel distribution company that deals with LPG distribution.
- Provide a subsidy to offset the initial cost of acquiring the LPG cylinder, gas, and cooker, or provide them with funding incentives for a certain number of sales.
- Create awareness about the subsidy program among the target community.
- Provide controls to prevent these products from being bought by traders to sell in neighboring regions.
- Once the LPG cyclinder has been acquired, it will be easier for the households to afford the refills.

Partner with two categories of organizations: one would be a major fuel distribution company and the second would support a credit purchase/long-term savings program to buy an LPG cylinder and cooker.

- This would be a tripartite model with the fuel distribution company dealing with LPG and the savings and loans organization providing a financing solution.
- The savings and loans organization would encourage consumers to save toward buying an LPG cylinder and cooker, and earn interest on amounts saved.
- Once a customer has saved enough, they would then authorize the transfer of their saved funds to the fuel company or would be issued with a voucher to pick their LPG cylinder, cooker, and gas.
- Create awareness about the subsidy program among the target community.
- Households would be able to sustain subseqent refills of LPG.

Table 69 outlines the challenges and risks anticipated with this model.

Table 69: Challenges and risks associated with the proposed partnership model for distributing LPG

Challenge/Risk	Anticipated mitigation measures
Hesitation by fuel distributors to extend their coverage to Kakuma and Kalobeyei.	Subsidies would help the potential organization meet some of its entry costs, although it may not make significant sales in the initial months before the program picks up. The results of this study will need to be used to demonstrate to investors the potential size of the market. The distributor could consider launching the small LPG container, potentially with a lighting attachment.
Subsidizing the cost of cylinders and burners introduces the risk of traders buying the subsidized items and selling them in neighboring regions, at a profit, without benefiting the intended beneficiaries.	To ensure that the intended target audience benefits from these subsidies, the subsidy grants could be provided to the consumers as a voucher or other identification that limits access to the subsidized items to one per family at outlets that sell LPG.
A model aimed at facilitating saving to purchase an LPG cylinder, a burner, and gas could be negotiated with a local financial institution. However, there is a risk that when a substantial amount is saved, it could be diverted to other uses.	Create links between the financial institution and LPG retailers to allow consumers to pay for the LPG cylinder, burner, and gas without withdrawing savings.

7.1.3: Enhance the efficiency of cash transfer programs with donor organizations

UNHCR and other donor organizations have provided refugees with food and firewood rations, as well as cash transfers to meet their various needs. In addition to the support from UNHCR, refugees receive cash grants from other donor organizations such as the World Food Programme. The efficiency of these cash transfer and donor support programs needs to be improved to give refugees the freedom to buy pre-approved non-food items from local vendors that would benefit their households and support local businesses.

KKCF should thus engage with these donors to develop a unified cash-based intervention program for refugees that would allow them to use their cash allocation on a card to purchase fuel and other energy solutions, and household items of their choice. Figure 8 outlines how this model would operate.

Figure 8: Proposed cash-based interventions for refugees living in the camps

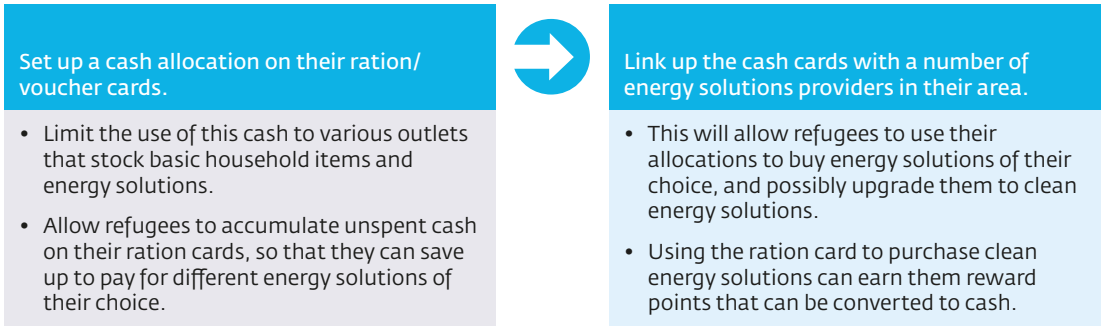


Table 70 outlines the challenges and risks anticipated with this model.

Table 70: Anticipated risks and challenges with cash-based interventions for refugees

Challenge/Risk	Anticipated mitigation measures
Lost cash cards.	Put in place a replacement model that allows the person to still access their accumulated savings on the cash card.
Monetizing the accumulated reward points for other energy needs only could frustrate the refugees.	Pursue opportunities to monetize the reward points.
Delays in transferring funds by one donor partner could erode the savings made on the card.	Coordinate the release of funds by the different donor partners to enable the refugee households to plan in advance.
With a coordinated funding mechanism, there is a risk that money from different organizations will be loaded onto the voucher at the same time, creating a high disposable income. Households that have financially disciplined decision makers could use that increased cash flow to make sound investment decisions such as acquiring alternative energy-efficient solutions. On the other hand, this increase in cash flow could predispose some households to reckless spending, which would defeat the purpose of such an initiative.	Engage one of the donor partners to train the beneficiaries on financial management.

7.2: Energy for lighting and productive use

A majority of households use solar lanterns (34 percent) and SHSs (18 percent) for lighting. Only 13 percent are connected to private electricity service providers, while only 5 percent are connected to grid power from Kenya Power. About 8 percent of households have no source of energy for lighting.

Among the businesses surveyed, 30 percent use SHSs for lighting, while 26 percent have access to power supplied by private electricity service providers. About 24 percent use solar lanterns, while 9 percent are connected to grid power from Kenya Power. About 11 percent of businesses reported having no lighting solution.

Based on this data, a number of potential business models are suggested.

7.2.1: Support private electricity service providers

Densify existing grids

Reliable electric power has a high aspirational score from both households and businesses, but Kenya Power is making slow progress in expanding access to electric power in the study regions. Refugee households are disadvantaged because they do not have national identity cards, which are required for connection. For these reasons, there is an opportunity to expand the use of mini-grids to meet the demand for electric power.

In Kakuma and Kalobeyei, there are 23 private electricity service providers, each operating on a small scale, except Renewvia. The mini-grids are not operating at maximum capacity because the customer base is too low for the mini-grids to run efficiently. For this reason, densifying existing grids is proposed. For instance, Renewvia should be supported to extend its coverage in Kalobeyei to village 2, while Yelele Limited should be supported to cover the whole of Kalobeyei village 3. Existing providers would need to be given additional grants to help them subsidize connection fees to expand their coverage.

In other areas, the private electricity service providers that are running sustainably can be supported with a grant to strengthen their power generation and distribution capacity, and encouraged to use renewable energy sources for power generation, as discussed next.

Establish more renewable energy-powered mini-grids to serve more customers

The study area is ideal for solar energy-backed mini-grids because there is high solar irradiation and vast open community land. However, financial viability of such a project needs to be carefully assessed.

Hybrid solar systems can be established and backed up by fossil fuel-supported generators. This could make generation cheaper, as the system would not be significantly dependent on expensive fossil fuels. It would also be possible to financially support investors to set up large-scale hybrid mini-grids, such as the one operated by Renewvia.

A more powerful solution is a hybrid solar power plant with battery backup and fossil fuel-fired generators. The batteries would store surplus electricity generated by the solar components, which would be used to cover energy needs when the solar components cannot generate electricity. When this stored energy runs out before the solar components can generate electricity again, fossil fuel-fired generators are activated to produce electricity. Batteries have a smaller environmental impact than fossil fuels and can provide enough flexibility for hybrid solar systems. While the initial investment cost for this type of power plant is higher, due to the cost of the batteries, the savings are higher for mini-grid providers, mainly arising from reduced fossil fuel consumption.

Invest in a power aggregation initiative

There is considerable duplication and a lack of coordination of activities among existing small-scale mini-grid operators, especially in Kakuma camp, leading to fragmentation in approach, inefficiency, and inability to scale up distribution and production. Moreover, the mini-grid operators are struggling to expand their customer reach – which is exposing them to inconsistent income flows that do not cover their energy generation costs.

A structure where the mini-grid operators produce electricity while another organization focuses on the distribution could address these issues. It is important to avoid disenfranchising existing operators by bringing in large mini-grid operators. To ensure support, investments made by existing mini-grid operators must not go to waste. For this reason, a partnership approach is proposed in which current mini-grid operators continue operating and supply their power to a power aggregating company that would then distribute it to customers.

This model would address the issue of fragmented mini-grid operations, assuring operators a steady flow of income. It would also provide enough power to meet the needs of households, and enable the standardization and rationalization of pricing for consumers. This model is similar to the approach adopted by KenGen, which buys power from local power producers, aggregates it, and then supplies it to Kenya Power for distribution.

The proposed model would also provide an opportunity to enhance mini-grid compliance with regulatory requirements, in addition to carrying out random mini-grid evaluation and inspection.

For this to work effectively, there is a need to estimate the demand required from the small mini-grids against their potential to supply. Demand potential must be projected for up to 20 or 30 years to evaluate the return on investment over time. Figure 9 outlines how this model would operate.

Figure 9: Model for partnership with current electricity service providers

Support the set-up of a local power aggregator/distributor.	This organization would then:
• Help the aggregator establish sustainable and reliable infrastructure for distribution – high-capacity cables, transformers, and power meters. • Support densification initiatives by this distribution organization.	• Sign up local power providers to supply power, which then gets distributed. • Set a purchase rate for power from these mini-grid operators. • Establish standards of operation and compliance for these mini-grid operators. • Plan for future growth and expansion to meet market demand.

Two challenges/risks are anticipated with this model, as noted in Table 71.

Table 71: Challenges associated with partnering with electricity service providers in Kakuma refugee camp

Challenge/Risk	Anticipated mitigation measures
Capital-intensive approach.	The model requires a significant amount of capital to rework the distribution infrastructure into one standardized and interconnected system. Funding would need to be explored, either through donor support or through attracting investors.
Lengthy process to obtain regulatory approval for the distribution company to operate.	KKCF to work in collaboration with the Turkana County Government, the Energy Regulatory Commission, and the Ministry of Energy at the national level.

Introduce a metered power consumption model

Most household consumers are willing to pay KES600 ($5.50) in monthly power costs while businesses would pay KES1,200 ($11). Many mini-grid providers charge consumers a standard fixed rate, making the supply unaffordable for many consumers. As such, there is an opportunity for a metered power consumption model where households pay a certain rate per kilowatt-hour consumed. As a result, households that consume more would pay more than those that consume less. A consumption-based pricing model may encourage the unserved to connect to the mini-grids. It would also ensure that costs are appropriately allocated among consumers, resulting in efficient use of energy based on the affordable loss principle.

This model would, however, need to address the cost of installing meters, including to existing customers.

Create partnerships to upgrade skills

As the number and size of mini-grids increases, it is necessary to think about training local technicians and support staff for these mini-grids.

Mini-grid operators struggle with set-up and repairs because there is a lack of skilled labor in the area. In an ideal situation, technicians for maintaining and repairing the mini-grids should work as employees of the operators or under long-term contracts. Technicians can be identified and deployed to the study locations to meet the maintenance and repair needs in the initial stages. To ensure a consistent supply of these technicians in the long term, an option is to partner with a tertiary-level training institution to provide training. Figure 10 outlines the proposed model.

Figure 10: Skills upgrading partnership model

Two challenges/risks are anticipated with this model, as outlined in Table 72.

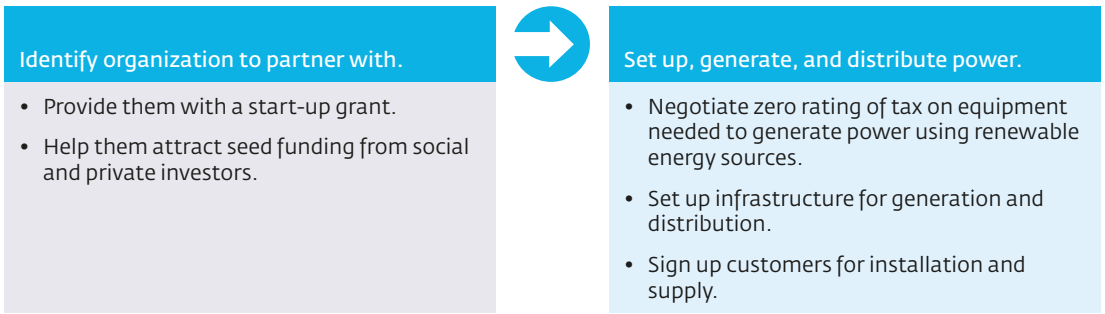
Table 72: Challenges associated with the skills upgrading partnership model

Challenge/Risk	Anticipated mitigation measures
Developing a curriculum that produces competent graduates that can support the mini-grids.	Engage with the Technical and Vocational Education and Training Authority to update the training curriculum in this area for TVET institutions.
Getting graduates to stay in the study area after training.	Provide continuous education of technicians locally through networking opportunities and financial incentives for them to stay and work in the area. Over time, locally trained technicians would become available.

Partner with donor organizations pursuing similar initiatives

It is necessary to create networks with agencies like GIZ and UNHCR to enable the establishment of larger-scale mini-grid networks. There is an opportunity to pursue this proposal with UNHCR, because it recently launched a request for prequalification for a tender to develop small solar PV systems to power its operations across three countries.[120] UNHCR aims to reduce emissions from the diesel generators powering its operations, particularly in large field compounds. Several organizations are doing the same, and partnerships on these energy projects can be pursued. These partnerships would potentially operate following the model outlined in Figure 11.

Figure 11: Model for partnerships with organizations to set up mini-grids or pursue grid densification with existing ones



120 African Energy, Kenya/Ethiopia/Uganda: UNHCR tenders for solar PV plants, https://www.africa-energy.com/article/kenyaethiopiauganda-unhcr-tenders-solar-pv-plants

7.2.2: Support initiatives seeking to expand the reach of solar lanterns and SHSs

As an alternative to supporting private electricity service providers, KKCF could pursue initiatives to increase the reach of solar solutions. Potential customers lack sufficient savings to acquire SHSs and struggle with access to credit, because their income is unstable. Several proposals are suggested below.

Enable local market access to durable and quality-assured SHS products

Only a few traders sell SHS products. This has resulted in monopolistic market tendencies such as low diversity in the product range available and an influx of poor-quality solar products. Thus, an initiative to increase the availability of affordable and durable products should be encouraged. Such an initiative could provide opportunities for new players.

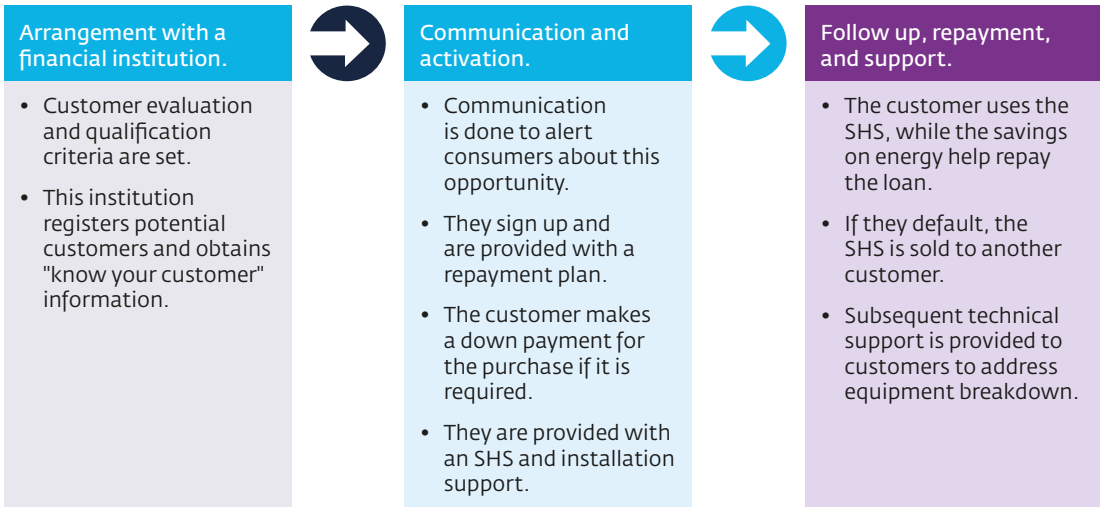
Build a pool of technicians that can install and maintain SHS products

Experienced technicians are needed to install and maintain SHS products that require installation. It would thus be necessary to build a pool of technicians, either through training or market linkages, who would install and maintain SHS products for a reasonable fee.

Create stronger links with financial institutions to support the purchase of SHSs

KKCF should pursue links with financial institutions to provide loans to acquire SHSs. On loan default, an SHS could be repossessed and sold to another customer. Figure 12 outlines how this model would operate.

Figure 12: Credit-supported purchase model for SHSs



The challenges and risks associated with this model are outlined in Table 73.

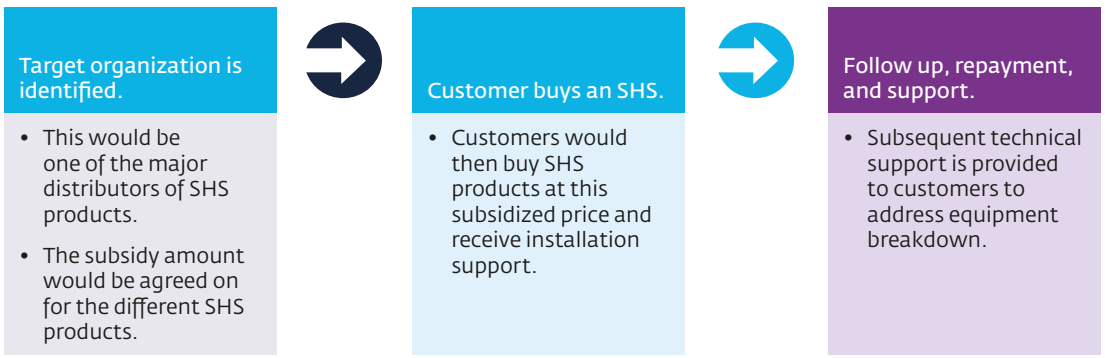
Table 73: Challenges associated with the credit-supported purchase model for SHSs

Challenge/Risk	Anticipated mitigation measures
Consumers defaulting on repayments.	Set up protocols for how to deal with defaults, including what to do about amounts already paid by the customer.
Issues around refugee identification.	Develop an approach to resolve the issue of refugees without identification documents (refugees are sometimes unable to fulfil know your customer requirements for mainstream service providers). For example, work with the Kenyan government to create a recognized identification card that can be used to register with financial service providers.
Reduced practicability of reselling the SHS to another customer on default.	To avoid damage of used items, have an experienced technician install the SHS. In addition, the lending institution can insure the amount lent, equivalent to the value of the SHS, to ensure that the financial institution is covered if it is unable to resell the SHS.
Equipment breaking down.	Have a pool of technicians that can provide breakdown maintenance during the repayment period.

Development partners could help subsidize purchases of SHSs

SHS products can also be subsidized. Subsidies could lead to a reduction in the purchase and installation cost, making the products more affordable for customers. Figure 13 outlines how the model would operate.

Figure 13: Subsidize the purchase of SHSs



One challenge is anticipated with this model.

Table 74: Challenge associated with the subsidy model to support the purchase of SHSs

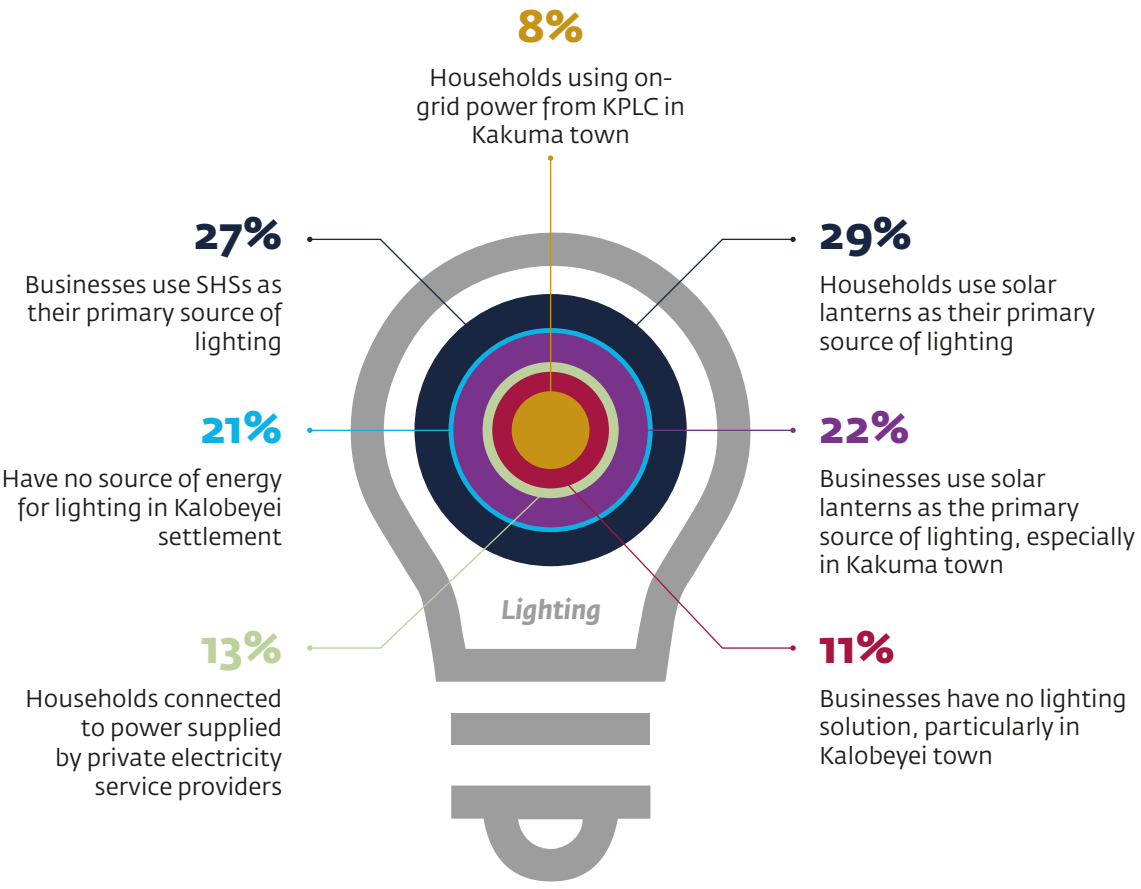
Challenge/Risk	Anticipated mitigation measures
Sustaining the subsidies.	Secure adequate funding from other donors and partner organizations to sustain subsidies for SHSs. In addition, engage with the government through private sector groups to zero rate tax on SHS products.

08

8. Conclusion and recommendations

8.1: Conclusion

The purpose of this baseline study was to understand energy demand and supply dynamics, households' and businesses' expenditures, willingness and ability to pay for energy products, and the potential market size in the Kakuma and Kalobeyei areas.



Solar lanterns are the primary lighting solution for households (29 percent), with the highest primary use being reported in Kakuma town (46 percent of households). Thirteen percent are connected to power supplied by electricity service providers (mini-grids and unregulated ones using generator sets). This is the primary energy source in Kakuma camp (17 percent), Kalobeyei settlement (12 percent), and Kalobeyei town (10 percent). Electricity from KPLC is only available in Kakuma town, with 8 percent of households in the town using it. About 8 percent of households have no source of energy for lighting, with the situation being particularly bad in Kalobeyei settlement (21 percent).

In contrast, 27 percent of business survey respondents use SHSs as their primary source of lighting. SHSs are more prevalent in the Kakuma refugee camp, where it was mentioned as the primary source of lighting by 31 percent of businesses, and Kalobeyei town, where 28 percent of businesses reported that this was their primary source of lighting. In addition, 26 percent of businesses use power supplied by private electricity service providers, with 21 percent using it as their primary lighting source.

Further, about 24 percent of businesses use solar lanterns, with 22 percent using it as their primary lighting source. Solar lanterns are most commonly used as the primary source of lighting in Kakuma town (33 percent) and Kalobeyei town (26 percent).

About 11 percent of businesses have no lighting solution. This figure increases to 15 percent for businesses in Kalobeyei town.

For cooking, 78 percent of households use firewood and 59 percent use charcoal. The latter is particularly prevalent in Kakuma town, where 79 percent of households use charcoal to meet their cooking needs. Refugees depend on firewood to meet their energy needs for cooking (with 92 percent of refugees in Kakuma camp using it) and receive free rations from UNHCR. Refugees also buy firewood from host community traders or collect it, which can be unsafe. Only 4 percent of households use LPG for cooking, with most of them being in Kakuma town.

There are few energy providers in the study locations and their operating capacity is limited, which affects their ability to scale up their services. Potential customers are unable to pay the full price for acquiring energy solutions such as an electricity connection, or buy an LPG cylinder, gas, and a burner in one lump sum, hindering the uptake of these products. For this reason, credit purchase models need to be pursued that take into account that the consumers do not have a steady source of income.

In addition, the lack of technicians in the study locations to maintain private producers' power equipment and SHSs would need to be addressed in the future.

8.2: Recommendations

Based on these findings, several business models and technical solutions to improve access to clean energy have been proposed, as outlined in Table 75.

Table 75: Proposed business models and technical solutions

Areas of intervention	Interventions
Energy for cooking	• Support initiatives that expand the use of energy-saving cookstoves. • Help households and businesses acquire LPG by partnering with one of the large fuel distribution companies to extend the scope of their operations to the Kakuma and Kalobeyei areas. There is also a need to support a credit purchase model where customers can deposit small amounts of money to go toward buying an LPG cylinder and cookers.
Energy for lighting and productive use	Support the expansion of private electricity service providers through the following measures: • Densify the existing grids. • Establish more renewable energy-powered mini-grids to serve more customers. • Aggregate power across current producers and have one supplier responsible for the distribution. • Introduce a metered power consumption model where households pay a certain rate per kilowatt-hour consumed rather than a flat rate. • Establish partnerships to upgrade technicians' skills. • Establish partnerships with other donor organizations pursuing similar initiatives such as GIZ and UNHCR to establish larger-scale mini-grids. • Enhance the efficiency of cash transfer programs with donor organizations to give beneficiaries the freedom to buy non-food items from a pre-approved list that includes several energy solutions. Support initiatives seeking to expand the reach of solar lanterns and SHSs. There is significant demand for these energy solutions, as this study has shown. However, potential customers lack sufficient savings to acquire SHSs and struggle with access to credit, mainly because their income is unstable. The following proposals are therefore suggested: • Improve quality assurance to encourage durable SHS products and lanterns. • Build a pool of technicians that can install and maintain SHS products. • Create stronger links with financial institutions to support the purchase of SHSs. • Engage with development partners to help subsidize the purchase of SHSs in the study areas.

9. Appendices

9.1: Study methodology and challenges

9.1.1: Study approach

The study used both quantitative and qualitative data collection approaches, as summarized below.

Figure 14: Summary of the data collection approach

Desk research

Key informant interviews

Interviews with consumers

Desk research

This study began with a review and analysis of existing data such as census data and other public domain datasets, reports, and data from UNHCR, GIZ, USAID, E41, MEI, and the 2019 Kenya Housing and Population Census, as well as laws, regulations, and strategies relating to the energy sector. The purpose of this desk research was to help contextualize the study location and the study subject.

This exercise helped shed light on the demographic trends in these areas, informed estimates of the market size, and gave insight into the living conditions and general living standards of the populations, as well as the challenges faced. In addition, it helped shed light on the regulatory framework for the energy sector.

Key informant interviews

Key informant interviews were conducted to gather market and supply-side information such as supply-side dynamics and the profile of the energy sector players in the study locations. The interviews also helped the team understand the challenges that energy product suppliers face, in addition to barriers to market entry. The information informed the modeling process of market opportunities presented in this report. The key informants that participated in this study are listed in Table 76.

Table 76: Key informant interview participants

Key informant/expert	Location	Number of interviews
Representative of Energy Regulatory Commission	Nairobi	1
Representative of Turkana County Government – Ministry of Lands, Energy, Housing and Urban Area Management (specifically, the Energy Directorate)	Lodwar	1
Representatives of d.light, Renewvia, Sun King, and LOKADO	Kakuma and Kalobeyei	5
Representatives of UNHCR and SNV	Kakuma and Kalobeyei	4
Total		**11**

Survey of consumers

A total of 1,051 quantitative interviews were conducted with household consumers to provide demand-side information. The interviews were weighted to reflect the distribution of the population living in these areas and the resultant sample is shown in Table 77.

Table 77: Sample distribution between refugee and host community households

		Number of households	Sample size targeted	Sample size achieved
Kakuma	Host communities	11,321[121]	260	265
Kakuma	Refugees	36,714[122]	468	600
Kalobeyei	Host communities	660[123]	63	67
Kalobeyei	Refugees	7,419[124]	210	119
Total		**56,114**	**1,000**	**1,051[125]**

In addition, a survey was conducted among 159 businesses. Table 78 shows how the interviews were distributed in the study locations.

121 This was based on the IFC study Kakuma as a Marketplace: A consumer and market study of a refugee camp and town in northwest Kenya, available: https://www.ifc.org/wps/wcm/connect/0f3e93fb-35dc-4a80-a955-6a7028d0f77f/20180427_Kakuma-as-a-Marketplace_v1.pdf?MOD=AJPERES&CVID=mc8eL2K. According to the study, there are about 60,000 people living in Kakuma town. Data from the 2019 Kenya Population and Housing Census shows that the average household size in Turkana West is 5.3, which was used to estimate the number of households.

122 This was based on UNHCR data on the population distribution and number of households per camp.

123 Based on a study done by Renewvia and GIZ, there are 3,500 people living in Kalobeyei town. The number of households was estimated based on the average household size of 5.3.

124 This was based on UNHCR data on the population distribution and number of households per camp.

125 In reporting the findings, data was weighted to adjust oversampling and undersampling errors in the sample achievement. This is the reason for the difference between the sample size reported in the data tables and the sample size reported as achieved.

Table 78: Number of commercial consumers interviewed

Area	Number of businesses targeted	Number of businesses interviewed
Kakuma town	40	12
Kakuma refugee camps	85	90
Kalobeyei town	10	39
Kalobeyei settlement	15	18
Total	**150**	**159**[126]

9.1.2: Study implementation stages

The implementation process and the number of interviews conducted under each data collection approach are summarized in Table 79.

Table 79: Summary of the implementation approach

Stage	Detailed activities
Project set-up	Involved desk research, questionnaire, and discussion guide design, CAPI scripting, and translation of the tool. The tool was translated into Swahili, Turkana, Juba Arabic, Somali, and Lingala.
Sampling distribution	A sample of 1,000 households (678 refugees and 322 hosts) and 150 businesses (100 in the camps and 50 in the host community) was distributed proportionately to the population living in host areas and the refugee camps.
Field preparation	• Involved interviewer selection, training, and pilot testing. • About 22 interviewers and 6 supervisors from both the host communities and refugee camps were trained.
Data collection	• 1,051 households (719 refugees and 332 hosts) and 159 businesses (108 in the refugee camps and 51 in the host community) were interviewed from the different sampling points. • Additionally, 11 key informant interviews were conducted with the different players in the energy sector.
Data analysis and reporting	Data was cleaned, processed, and analyzed, with findings for the different questions presented in this report.

126 The same comment applies to the businesses. In reporting the findings, data was weighted to adjust oversampling and undersampling errors in the sample achievement. This is the reason for the difference between the sample size reported in the data tables and the sample size reported as achieved.

9.1.3: Fieldwork challenges and limitations

Table 80 outlines the challenges experienced while collecting data.

Table 80: Fieldwork challenges and limitations

Challenge	Details
Poor network connectivity	Some areas, especially Kakuma 1, have very poor internet connectivity, which hampered real-time submission of the data from mobile devices to the Ipsos servers. This impacted real-time review of the data as it flowed onto the servers. However, the quality checks were accomplished through other means, such as supervision and back calling the respondents.
Hostility within the Somali-dominated blocks	Despite using locally hired enumerators who could speak the Somali language, seven refusals in the Somali-dominated blocks were encountered. The seven households were suspicious of the reason for the enumerators' presence in their household. These households were replaced with other households within the same block.
Flooding	Heavy rains rendered the camps inaccessible because of flooding on some days. Fieldwork had to be interrupted until the situation improved.
Respondents not at home	The time of data collection coincided with UNHCR distributing food. Most decision makers had gone to collect food parcels, and this caused the enumerators to return several times to interview them.
Consumers of electric power could not share consumption information in kWh	Current consumers of electric power from the mini-grids in the study locations do not know their current consumption in kWh. This is because they pay a monthly flat rate for electricity. If these mini-grids transition to consumption-based payment models, it will become easier to obtain consumption information in kWh from consumers in the future. Consumption information in kWh is more accurate in estimating current consumption and would be more reliable in projecting future demand. With the study areas facing significant population growth, this information would be essential in making projections for long-term planning.

9.2: Electrical worker and contractor license fees and penalties

9.2.1: Fees

The Electric Power (Electrical Installation Work) Rules (2006) categorizes licenses for electrical workers into five classes:

- Class C-2 entitles the holder to carry out electrical installation work for connection to a single-phase supply at low voltage, restricted to up to two-storey residential and commercial buildings not used as factories or places of public entertainment.
- Class C-1 entitles the holder to carry out electrical installation work as in Class C-2, and for connection to a three-phase supply at low voltage, restricted to up to four-storey buildings not used as factories or places of public entertainment.
- Class B entitles the holder to carry out electrical installation work as in Class C-1, but without a limitation on the building height or use, and for connection to supply metered at voltages not exceeding medium.
- Class A-1 entitles the holder to carry out all kinds of electrical installation work.
- Class A-2 entitles the holder to carry out specialized electrical installation work.

Applicants for an electrical worker license must pay an application fee, as outlined in Table 81.

Table 81: Application fees for licenses for electrical workers

Class/Category of license	Application fees charged (KES)
Class C-2	250
Class C-1	500
Class B	750
Class A-1	1,000
Class A-2	1,000

Once the license is granted, a license fee must be paid.

Table 82: License fees for electrical worker licenses

Class/Category of license	License fee charged (KES)
Class C-2	1,000
Class C-1	2,000
Class B	3,000
Class A-1	5,000
Class A-2	5,000

The licenses are valid for three years, after which time a license renewal fee must be paid, as outlined in Table 83.

Table 83: Renewal fees for electrical worker licenses

Class/Category of license	License renewal fee charged (KES)
Class C-2	500
Class C-1	750
Class B	1,000
Class A-1	2,000
Class A-2	2,000

The Electric Power (Electrical Installation Work) Rules (2006) categorizes electrical contractor licenses into five classes. The application fees for the different classes are outlined in Table 84.

Table 84: Application fees for licenses for electrical contractors

Class/Category of license	Application fees charged (KES)
Class C-2	250
Class C-1	500
Class B	750
Class A-1	1,000
Class A-2	1,000

Once the license is granted, a license fee must be paid.

Table 85: License fees for electrical contractor licenses

Class/Category of license	License fee charged (KES)
Class C-2	1,000
Class C-1	2,000
Class B	3,000
Class A-1	5,000
Class A-2	5,000

These licenses are valid for three years, after which time a license renewal fee must be paid, as outlined in Table 86.

Table 86: Renewal fees for electrical contractor licenses

Class/Category of license	License renewal fee charged (KES)
Class C-2	1,000
Class C-1	2,000
Class B	3,000
Class A-1	5,000
Class A-2	5,000

The fees for an application or license for an electrical worker and an electrical contractor are the same. However, renewal fees for an electrical contractor license are higher than those charged for an electrical worker license.

9.2.2: Penalties

It is the duty of any person planning, building, operating, or maintaining a transmission or distribution system to ensure that such works are carried out only by electrical contractors and electrical workers duly authorized by EPRA.[127]

Failure to do so exposes both the contractor and the person permitting them to carry out works to penalties. It is therefore important that initiatives supported by KKCF use licensed providers.

Section 152 of the Energy Act states that a person who carries out electrical installation work while not duly authorized as an electrical worker or contractor commits an offence and, on conviction, is liable to a fine not exceeding KES100,000, a term of imprisonment not exceeding six months, or both. Further, a consumer who permits an unauthorized person to carry out electrical installation work on his premises commits an offence and is liable to a fine not exceeding KES50,000, a term of imprisonment not exceeding three months, or both.

Additionally, a licensee or licensing authority who permits an unauthorized person to carry out electrical installation work on their behalf commits an offence and is liable to a fine not exceeding KES1 million, a term of imprisonment not exceeding six months, or both.

127 Section 151, Energy Act.

9.3: Draft Energy (Solar Photovoltaic System) Regulations (2020)

Table 87: Proposed categories of licenses for technicians/solar PV system workers

Category of license	What the technician can do	Qualifications required	Application fee (KES)	License fee (KES)	Renewal fee (KES)	Minimum professional indemnity cover (KES)
Class SPW1	Design, install, test, commission, maintain, and repair solar PV systems with a single inverter, single charge controller, and single or multiple solar PV modules of a maximum combined capacity of 400 Wp.	• Kenya Certificate of Primary Education (KCPE) or equivalent, Electrical Government Trade Test 2, and basic solar PV training from an accredited institution. • Completion certificates of at least three solar PV systems of at least 100 watts each that the applicant has been involved in directly.	250	1,000	2,250	N/A
Class SPW2	Design, install, test, commission, maintain, and repair: • Solar PV systems with a maximum PV array of 3 kWp, a single inverter/ charger connected to the grid or a backup generator, a charge controller of up to 70 amperes, and multiple batteries. • Solar water pumping systems with a maximum capacity of 3 kWp.	• Kenya Certificate of Secondary Education (KCSE) or equivalent, Certificate in Electrical Engineering and Electronics, and intermediate solar PV training from an accredited institution; or • Bachelor degree or Higher National Diploma or Diploma in Electrical Engineering and intermediate solar PV training from an accredited institution; or • Bachelor degree with at least three units/courses specific to electrical engineering and intermediate solar PV training from an accredited institution. **In addition, they must have:** • Completion certificates of at least three solar PV systems of at least 1 kW each that the applicant has been involved in directly. • Design documentation of at least three installed solar PV systems of at least 1 kW each that the applicant has been involved in directly.	500	2,000	3,000	1 million

Category of license	What the technician can do	Qualifications required	Application fee (KES)	License fee (KES)	Renewal fee (KES)	Minimum professional indemnity cover (KES)
Class SPW3	Design, install, test, commission, maintain, and repair: • Grid-tied solar PV systems with a maximum capacity of 50 kWp. • Single-phase hybrid systems not exceeding 10 kWp or direct current coupled with a single battery inverter or multiple batteries. • Solar water pumping systems with a maximum capacity of 50 kWp.	• Bachelor degree or Higher National Diploma or Diploma in Electrical Engineering and advanced solar PV training from an accredited institution; or • Bachelor degree with at least three units/courses specific to electrical engineering and advanced solar PV training from an accredited institution. **In addition, they must have:** • Completion certificates of at least three grid-tied systems of 15 kW each and one hybrid system of at least 3 kW that the applicant has been involved in directly. • Design documentation of at least five installed solar PV systems of at least 3 kW each that the applicant has been involved in directly.	750	3,000	4,500	5 million
Class SPW4	Design, install, test, commission, maintain, and repair solar PV systems of any capacity.	Holder of class SPW3 certificate and Bachelor degree in Electrical Engineering, in addition to having: • Completion certificates of at least three installed solar PV systems of at least 50 kW each that the applicant has been involved in directly. • Design documentation of at least five installed solar PV systems of at least 50 kW each that the applicant has been involved in directly. • Demonstrable skills in financial analysis of energy projects.	1,500	4,000	6,000	10 million

Table 88: Proposed categories of licenses for solar PV system contractors

Category of license	What person can do with this license	Qualifications required	Application fee (KES)	License fee (KES)	Renewal fee (KES)	Minimum professional indemnity cover (KES)
Class SPC1	• Import and sell solar PV components, provided that the solar PV module rating does not exceed 400 Wp and inverters do not exceed a capacity of 400 watts. • Design, install, test, commission, maintain, and repair solar PV systems with a single inverter, charge controller, and single or multiple solar PV modules not exceeding 400 watts.	The licensee must be, or have in his employ, a class SPW1 worker.	1,000	2,000	3,000	N/A
Class SPC2	• Import and sell solar PV and solar water pumping components, provided that the inverters sold or offered for sale do not exceed a capacity of 3 kW. • Design, install, test, commission, maintain, and repair solar PV systems with a maximum PV array of 3 kWp, a single inverter/ charger connected to the grid or a backup generator, a charge controller of up to 70 amperes, and multiple batteries. • Design, install, test, commission, maintain, and repair solar water pumping systems with a maximum capacity of 3 kWp.	The licensee must be, or have in his employ, a class SPW2 worker.	2,000	3,000	4,500	N/A
Class SPC3	• Import and sell solar PV systems and components and solar water pumping systems, provided that the inverters sold or offered for sale do not exceed a capacity of 50 kW. • Design, install, test, commission, maintain, and repair grid-tied solar PV systems not exceeding 50 kWp or single-phase hybrid systems not exceeding 10 kWp, or direct current coupled with a single battery inverter; the contractor may connect multiple batteries. • Design, install, test, commission, maintain, and repair solar water pumping systems with a maximum capacity of 50 kWp.	The licensee must have class SPW3 workers.	3,000	5,000	6,000	N/A

Category of license	What person can do with this license	Qualifications required	Application fee (KES)	License fee (KES)	Renewal fee (KES)	Minimum professional indemnity cover (KES)
Class SPC4	• Import and/or sell solar PV products. • Design, install, test, commission, maintain, and repair solar PV systems of any capacity.	The licensee must be, or have in his employ, a class SPW4 worker.	4,000	7,500	9,000	N/A
Class SPM	• Import parts necessary for the manufacture of solar PV components. • Manufacture and sell solar PV components and systems.	N/A	3,000	5,000	6,000	N/A