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Energy for Household Uses in Refugee Settlements in Uganda

Desk Review for the Uganda refugee response

Save the Children

Uganda Learning, Evidence, Accountability, and Research Network

About the USAID Uthabiti Activity

The USAID-funded Uthabiti Activity is implemented by Save the Children, in partnership with Uganda Response Innovation Lab (U-RIL), Swisscontact, and Grameen Foundation. It is facilitating diverse resilient and sustainable livelihood strategies for refugees and host communities in Isingiro and Lamwo districts. Uthabiti focuses on promoting livelihood opportunities in primarily off-farm activities while also addressing critical gaps in the selected value chains that limit economic activity, including access to skills, energy and financial services.

About U-Learn

The UK Aid-funded *U-Learn* consortium is led by the Uganda Response Innovation Lab (U-RIL), in partnership with IRC and IMPACT Initiatives. Its objective is to generate and encourage uptake of evidence and insights for the Uganda refugee response.

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Energy for Household Uses in Refugee Settlements in Uganda

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Acronyms

ACE	Africa Clean Energy
ACS	Advanced cookstove
CEFA	Clean Environment for Africa Uganda
CO	Carbon monoxide
CO^2	Carbon dioxide
DCA	Danish Church Aid
EASP	Electricity Access Scale-Up Project
EPC	Electric pressure cooker
ESDS	Energy Solutions for Displacement Settings
ESMAP	Energy Sector Management Assistance Program
g/MJd	Grams per megajoule
ICRAF	International Centre for Research in Agroforestry
ICS	Improved cookstoves
GoU	Government of Uganda
LPG	Liquified petroleum gas
Mg/MJd	Milligrams per megajoule
MSME	Micro, small, and medium-sized enterprises
MTF	Multi-tier framework
NDP III	Third National Development Plan
PAYGo	Pay-as-you-go
$PM_{2.5}$	Particles that are 2.5 microns or less
PUE	Productive use of energy
PV	Photovoltaic
RBF	Results-based financing
SDG	Sustainable Development Goals
SGBV	Sexual and gender-based violence
SHS	Solar home systems
SERP	Sustainable energy Response Plan for Refugees and Host Communities
W	Watt
Wh	Watt hours
UNBS	Uganda National Bureau of Standards

Energy for Household Uses in Refugee Settlements in Uganda

Executive summary

Energy is essential to meet basic human needs, yet the majority of refugee and host community households in Refugee hosting areas have minimal access to basic sources of energy. They rely primarily on firewood and charcoal, whose use drives deforestation and land degradation. This review summarizes the existing literature on energy for household use in refugee-hosting districts of Uganda and provides information on the background, advances, challenges, and recommendations on energy for household use.

Energy is used at household level to meet basic needs and to facilitate domestic tasks. Energy for household uses is often separated into two distinct areas: 1) electricity for lighting and powering devices; and 2) energy for cooking. Energy access and utilisation is a multi-dimensional issue influenced by factors like the availability, affordability, efficiency, and safety of the energy source.

In rural or remote areas where only 5% of households have grid access, there have been efforts to increase access to off-grid solutions for lighting. A majority of refugee households use low-watt pico-PV solar lighting products (38%), non-rechargeable torches (36%), or solar home systems (12%).[1] Few refugee (3%) and host community (12%) households use fuel-based energy, like kerosene lamps or candles. The main barriers to adopting clean energy for lighting are availability, affordability, and willingness to pay.

In regard to cooking, the majority of refugee and host community households (99%) use wood biomass, in the form of firewood or charcoal. Most households use the traditional three-stone open fire, with greater use in host communities (76%) than refugee households (46%).[2] There is low adoption of briquettes, but local groups have received support to manually produce briquettes in select refugee settlements. The use of cleaner fuels (e.g. liquid petroleum gas, electricity, biogas) in settlements is limited. The main challenges to improving energy for cooking are the awareness, affordability, willingness to pay, availability in local markets, the perceived change in taste of food, and gender roles in financial decision-making.[3]

To improve household access to energy in refugee settlements, actors can continue to encourage the adoption of efficient cooking technologies while increasing electricity access over the long term. Strategies that can be scaled up are increasing the demand and supply of non-wood fuels like biomass briquettes, improving access to flexible financing, strengthening supply

[1] International Finance Corporation (IFC), *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[2] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[3] EnDev, *The State of Sustainable Household Energy Access in Refugee Settings in Uganda: Survey Findings in Rhino Camp Settlement and Imvepi Settlement, Arua District, West Nile Region*. GIZ, 2019; IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022; Elasu, J., Ntayi, JM, Adaramola, M., Buyinza, F., Ngoma, M., and Atukunda, R. Gender role differentiation in household fuel transition decision-making: Implications for education and training in Uganda. Frontiers in Sustainability. 22 February 2023 https://www.frontiersin.org/articles/10.3389/frsus.2023.1034589/full

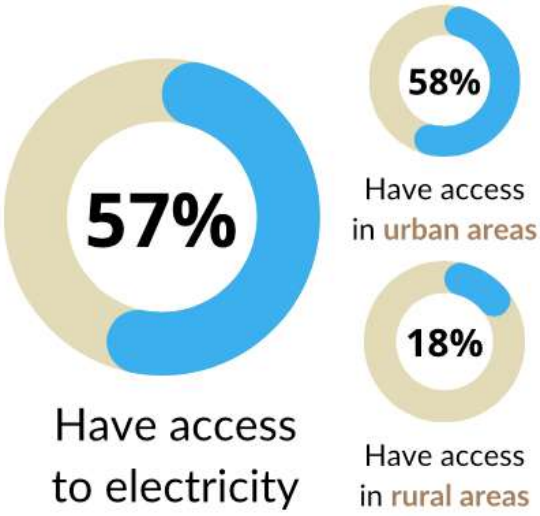
chains for energy products, engaging women in energy businesses and value chains, and strengthening coordination between key actors.

1. Introduction

Energy is a core pillar of sustainable development and is essential to meet basic human needs including cooking, lighting, heating, and accessing clean water. Yet, millions of displaced people around the world have inadequate access to safe and reliable energy.[4] Access to energy is increasingly integrated into humanitarian interventions in displacement settings, in particular the humanitarian-development-peace nexus, recognizing energy as both a fundamental need and an enabler for longer-term development. Improving refugee and host community households' access to clean energy can improve their health and safety, reduce gender-based violence, reduce time spent on labour-intensive domestic chores, and provide opportunities for income generation including increasing women's participation in the energy value chain.[5]

With more than 1.55 million refugees, Uganda is Africa's largest refugee-hosting country. The Government of Uganda's Third National Development Plan (NDP III) recognizes that reliable energy is critical for poverty reduction and society's social and cultural transformation.[6] The Ministry of Energy and Mineral Development developed the *Sustainable Energy Response Plan for Refugees and Host Communities (SERP)*, which will help advance its goals by increasing refugee and host communities' access to affordable, reliable and clean energy.[7] The SERP focuses on increasing energy access for household and productive uses, decreasing reliance on biomass, and increasing awareness and adoption of clean energy solutions.

The Government of Uganda (GoU) is also committed to the Sustainable Development Goals (SDG). The GoU has made progress on SDG 7: Affordable and Clean Energy by increasing the population's access to electricity.[8] More than half (57%) of the population in Uganda has access to electricity, including on-grid (19%) and off-grid (38%) connections.[9] There is higher electricity access in urban areas (58%) than



[4] Grafham, O., Lahn, G., and Haselip, J., *Scaling sustainable energy services for displaced people and their hosts. Chatham House*, 2022.

[5] Baldi, D., Moner-Girona, M., Fumagalli, E., and Fahl, F., *Planning sustainable electricity solutions for refugee settlements in sub-Saharan Africa*, 2022. Nature Energy. 7, 369-379.

[6] National Planning Authority, *Third National Development Plan (NDPIII) 2020/21-2024/25*, 2020.

[7] Ministry of Energy and Mineral Development (MEMD), *Sustainable Energy Response Plan for Refugees and Host Communities (SERP) 2022-2025*, 2022.

[8] Tracking SDG7, *The Energy Progress Report*, 2023. https://trackingsdg7.esmap.org/country/uganda Accessed on October 4, 2023.

[9] African Development Bank Group, *Uganda launches last-mile connectivity to increase electricity access to rural communities,* 2021. https://www.afdb.org/en/news-and-events/press-releases/uganda-launches-last-mile-connectivity-increase-electricity-access-rural-communities-45797

in rural areas (18%).[10] Only 2% of the host community and 1% of refugee households are connected to the national grid.[11]

There has been less progress on improving access to clean energy for cooking. The majority of refugee (89%) and host community (93%) households have minimal access to basic energy services to meet human needs, disproportionately affecting female-headed households.[12] Biomass in the form of firewood or charcoal is the most common source of energy used for cooking in urban and rural households throughout Uganda.[13] The reliance on wood biomass is a key driver of deforestation, as wood is being harvested faster than it can regenerate. It is estimated that Uganda loses 4% of forest cover loss each year, which increases carbon emissions, land degradation, soil erosion, and biodiversity loss.[14] There are also increased risks for women and girls, who are predominantly responsible for the domestic chores of collecting wood and cooking. As wood becomes scarce, the distance women and girls walk increases, exacerbating risks of sexual and gender-based violence (SGBV). Furthermore, the burning of biomass fuels escalates household indoor air pollution, which is linked to health threats such as chronic obstructive pulmonary disease and premature deaths.[15]

This review summarizes existing literature on energy for household uses in refugee-hosting districts of Uganda. It provides a brief background on energy in general and two main household uses (lighting and cooking), progress and challenges of energy for lighting and cooking in refugee-hosting districts, and key recommendations. The review complements a previous report exploring the *Productive Use of Energy (PUE) in Uganda's Refugee Response* to facilitate income generation for refugee and host communities. This review is aimed at actors involved in the refugee response seeking to improve access to clean energy for household use in refugee-hosting districts.

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[10] The UN Refugee Agency (UNHCR), *Access to Clean Energy for Refugees: Uganda Case Studies*, 2022.

[11] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022

[12] MEMD, *Sustainable Energy Response Plan for Refugees and Host Communities (SERP) 2022-2025*, 2022.

[13] Baldi, D., Moner-Girona, M., Fumagalli, E., and Fahl, F., *Planning sustainable electricity solutions for refugee settlements in sub-Saharan Africa*, 2022. Nature Energy. 7, 369-379.

[14] UNHCR & OPM, *Inter-Agency Uganda Country Refugee Response Plan (UCRRP)*, 2022; Price, R., *"Clean" Cooking Energy in Uganda – technologies, impacts, and key barriers and enablers to market acceleration*, Institute of Development Studies, 2017.

[15] Van Gemert, F., et. al., *Effects and acceptability of implementing improved cookstoves and heaters to reduce household air pollution: a FRESH AIR study*. Primary Care Respiratory Medicine, 2019. 29; 32.

2. Energy for household use

2.1 Background

There are three types of energy: electrical, thermal, and mechanical. Energy can be used for a range of applications to reduce time spent on tasks, reduce labour or improve efficiency, among other reasons (see the Productive Use of Energy report).

According to the UN's Advisory Group on Energy and Climate Change[16], there are three levels of energy demand:

1) **Basic human needs:** The minimum energy demand, covering fuel for cooking and heating, and electricity for lighting, communication, health and education.
2) **Productive use of energy (PUE):** In addition to energy for basic needs, PUE incorporates energy used to generate income. E.g.: agricultural, industrial commercial production.
3) **Modern society needs:** The third level adds energy for domestic appliances, cooling and heating, and private transportation.

Household use of energy in the refugee context mainly corresponds to the first level: meeting basic human needs. It includes improving access to clean energy for cooking, lighting, communications (radio, phones), heating or filtering water, and powering small appliances to facilitate domestic tasks.

Strategies to increase household energy access have generally focused on two distinct uses: 1) energy for lighting and power; and 2) energy for cooking. The two areas are treated separately in this review because the energy sources often differ.

Access to energy is multi-dimensional issue. A common standard for rating energy access is the Multi-Tier Framework for Energy Access (MTF), developed by World Bank and the Energy Sector Management Assistance Program (ESMAP). Two MTF were developed to measure access to electricity and access to energy for cooking, which will be discussed in the following sections. The MTF is based on the theory of the "energy ladder", which assumes that as income increases, households will adopt a higher form of energy, moving from a lower tier to a higher tier energy source like a ladder. However, in reality "fuel stacking" is more common, where households use additional energy fuels rather than replacing the old ones completely.[17]

2.2 Energy for lighting

The MTF for electricity access is a six-tier scale measured by the following seven attributes (see Table 1):[18]

1) **Power capacity:** Number of Watts (W) or daily Watt hours (Wh) generated.
2) **Availability:** Number hours that electricity is available in the day and evening.
3) **Reliability:** Number of disruptions per week.
4) **Quality:** Occurrence of voltage problems.
5) **Affordability:** Proportion of household income spent on a standard number of Wh.

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[16] The Secretary-General's Advisory Group on Energy and Climate Change (AGECC). 2010. Energy for a sustainable future. Report and Recommendations. April 28, 2010. New York.

[17] Nyukiki, E., Okello, D., Mambo, W., Mugonola, B., *Drivers of household demand for cooking energy: A case of Central Uganda*, 2022. Heliyon. 8 (3).

[18] Multi-Tier Framework, Electricity, 2022. https://mtfenergyaccess.esmap.org/methodology/electricity

6) **Formality:** Bill payments to formal entities for electricity use.
7) **Health and safety:** Serious accidents occurring due to electricity connection.

Table 1: Multi-tier framework for electricity (adapted from Multi-Tier Framework, 2022)

Attributes		Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Capacity	Watts	Less than 3W	At least 3W	At least 50W	At least 200W	At least 800W	At least 2kW
	Daily Watt hours	Less than 12Wh	At least 12Wh	At least 200Wh	At least 1 kWh	At least 3.4 kWh	At least 8.2kWh
Availability	Daily	Less than 4h	At least 4 hours		At least 8h	At least 16h	At least 23h
	Evening	Less than 1h	At least 1 hour	At least 2 hours	At least 3h	At least 4h	
Reliability		More than 14 disruptions per week			3-14 disruptions per week	< 3 disruptions of >2h	<3 disruptions of <2h
Quality		Voltage problems that damage appliances				Voltage problems do not affect use of appliances	
Affordability		Cost of 365kWh package per year is >5% of household income			Cost of 365kWh package per year is <5% of household income		
Formality		No bill payments for the use of electricity				Bill is paid to utility or authorized representative	
Health and Safety		Serious or fatal accidents due to electricity connection				No past accidents	
Example of energy source		Fuel-based lighting	pico-PV light SHS (10W)	SHS	SHS Mini-grid	Mini-grid Main grid	Mini-grid Main grid

Fuel-based lighting options tend to be inefficient, provide poor quality light and pose health and fire hazards, and thus are categorized as Tier 0. Single light sources like solar lamps and flashlights are Tier 1 technologies. Lighting technologies that are higher on the MTF include off-grid[19] and on-grid options:

- **Decentralised off-grid or standalone systems:** These are small systems or devices used by a single person or household. Solar-powered off-grid options includes low-Watt pico-PV devices (e.g. solar lanterns) and higher-Watt solar home systems (SHS). SHS range from small (10 Watts) to large (200 Watts) and can power lights, radio, and a variety of appliances.[20]
- **Mini-grids (also nano- and micro-grids):** Mini-grids are an off-grid solution. They include a connection to a local mini-grid that has one or more small power generation units. They generate between 200 to 10,000 Watts. They can supply electricity to a small area, such as a village, or to over 500 households.[21]
- **On-grid:** High-tier electricity from the national grid, which can be powered by non-renewable (fossil fuels) and/or renewable (e.g. solar, wind, hydropower) sources.

There are several types of lighting options that can be broadly categorized in two types: 1) traditional fuel-based lighting and 2) electric lighting. Electric lighting can be further categorized into: (i) battery-powered devices, (ii) solar-powered devices, and (iii) lighting powered by a

[19] Not connected to the national electricity grid system

[20] Utz, V., *Modern Energy Services for Modern Agriculture: A review of smallholder farming in developing countries*. GIZ, 2011.

[21] Energypedia. *Mini-grids,* 2022. https://energypedia.info/wiki/Mini_Grids. Page accessed October 3, 2023.

centrally generated source of electricity. Table 2 summarizes different types of lighting sources that are being used in refugee settlements and host communities in Uganda.[22]

Table 2: Type of energy for lighting (CREEC, 2020; Energypedia, 2022)

Type of Energy		Description
Traditional fuel-based lighting		
TIER 0	Kerosene lamp	A lamp fuelled by burning kerosene and protected by a glass cover. It is also known as a hurricane lamp.
	Tadooba	An open-wick kerosene lamp in a canister, known as 'tadooba' in Uganda.
	Candles	A burning wick surrounded by wax or fat.
	Dried grass or wood	Burning a combustible material like wood or grass to produce light.
Electric lighting		
TIER 1	**Battery-powered lighting**	
	Single use torch	Single use torches can only be used once or even for a few hours.
	Dry-cell and bulb	A make-shift small bulb connected to a dry-cell battery.
	Torch (flashlight)	Battery-powered handheld light.
	Rechargeable torch or phone torch.	Handheld flashlight that can be recharged by a source of power, or the light on mobile phones.
TIER 1-2	**Solar-powered lighting**	
	Solar lamps and lanterns (pico-PV)	Portable, lightweight lamps and lanterns available in a variety of sizes and a power output between 1 and 10 Watts. The solar lantern consists of a solar panel, LED light, battery, and charge controller, and sometimes includes a mobile phone charger.
	Solar multi-light system or mini solar home system (pico-PV)	A pico-PV product of up to 10 Watts that has up to three or four lights with a standalone solar panel and rechargeable battery, and USB charging for phones.
	Solar torch/flashlight	Handheld, portable light with an integrated solar module.
TIER 3-5	**Lighting from centrally generated electric power**	
	Electric lamps, light fixtures, and light bulbs	Lighting products powered by electricity provided through a central source, including: - Solar home system (10 to 200 Watts) - A mini-grid (1kW – 10MW) - The national grid (>2kW)

[22] Centre for Research in Energy and Energy Conservation (CREEC), *Final Report: Baseline Assessment for Market-based Energy Access for Scale up Projects in Refugee Settlements in Uganda*, GIZ, 2020.; Energypedia, *Features of PicoPV Systems*, 2022. https://energypedia.info/wiki/Features_of_PicoPV_Systems.

2.3 Energy for cooking

The MTF for cooking measures access to energy according to six attributes relating to both the fuel and the type of cookstove used:[23]

1) **Exposure[24]:** Personal exposure to pollutants, which decreases as ventilation improves.
2) **Efficiency:** Combustion and heat-transfer efficiency of the stove, which can be improved by providing an insulated chamber around and above the flame.
3) **Convenience:** Time collecting or purchasing fuel and preparing the stove.
4) **Availability:** Readiness of the fuel when needed.
5) **Safety:** Occurrence of injuries, such as burns caused by an open flame, hot metal or tipping pot/stove.[25]
6) **Affordability:** Share of household budget spent on fuel.

The attributes are scored across a scale of 6 tiers (0-5), where higher tiers reflect improved cookstoves and fuels (see Table 3).[26,27,28] Most improved cookstoves (ICS) are categorized in a Tier 2 or 3 category. A household would have access to 'modern energy' for cooking if it scores Tier 4 or above on all six attributes.

Table 3: Multi-tier framework for cooking (adapted from Multi-Tier Framework, 2022 and Price, 2017)

Attributes		Tier 0	Tier 1	Tier 2	Tier 3	Tier 4	Tier 5
Exposure	Ventilation	Poor	Poor	Improved	Improved	Good	Good
	$PM_{2.5}$ (mg/MJd)	>1030	≤1030	≤481	≤218	≤62	≤5
	CO (g/MJd)	>18.3	≤18.3	≤11.5	≤7.2	≤4.4	≤3.0
Efficiency		≤ 10%	>10%	>20%	>30%	>40%	>50%
Convenience	Fuel acquisition (hour/week)	≥7		<7	<3	<1.5	<0.5
	Stove preparation (min/meal)	≥15		<15	<10	<5	<2
Safety		Serious accidents over the past 12 months		Serious accidents over the past 12 months		No serious accidents over the past 12 months	
Affordability	Fuel cost	≥5% of household income; Fuel is collected often for free. ($0-30)		≥5% of household income ($0-18)		Fuel cost <5% of household income	
	Stove cost	$0-$5		$10-30		$40-100	
Fuel Availability		Primary fuel available less than 80% of the year				Available 80% of year	Readily available

[23] The World Bank, *Multi-Tier Framework for Cooking: A Comprehensive Assessment Method to Measure Access to Modern Energy Cooking Services*, 2020. https://www.worldbank.org/en/topic/energy/brief/fact-sheet-multi-tier-framework-for-cooking

[24] Exposure is measured by the emissions of carbon monoxide (CO) in grams per megajoule (g/MJd) and particles that are 2.5 microns or less (PM2.5) in milligrams per megajoule (mg/MJd).

[25] Energypedia, *Improved Cookstoves and Energy Saving Equipment*, 2022. https://energypedia.info/wiki/Improved_Cookstoves_and_Energy_Saving_Cooking_Equipment#:~:text=Cookstoves%20are%20commonly%20called%20%E2%80%9Cimproved,charcoal%2C%20agriculture%20residues%20or%20dung.

[26] Multi-Tier Framework, *Cooking*, 2022. https://mtfenergyaccess.esmap.org/methodology/cooking

[27] Energypedia, *Cooking Energy Matrix*, 2022. https://energypedia.info/images/b/b5/MTF_cooking.jpg

[28] Price, R., *"Clean" Cooking Energy in Uganda – technologies, impacts, and key barriers and enablers to market acceleration*, Institute of Development Studies, 2017.

Stove technology	Type	Traditional stove	Simple improved stove	Intermediate improved stove	Advanced stoves	Bio-stove	Electric pressure cooker
	Fuel	Solid fuel (Wood)	Unprocessed fuel (Wood, charcoal)	Charcoal, pellets, briquettes	Biogas, Forced air gasifier with pellets	Biogas, LPG, ethanol	Electricity Biogas LPG

The fuel sources used for cooking include biomass and biomass-based fuels that are derived from living or recently living organisms (plant or animal), as well as cleaner solutions like liquefied petroleum gas (LPG) and electricity (see Table 4).[29] Strategies to improve energy access for cooking aim to help households move from traditional fuels (firewood) to more efficient (charcoal), transitional (kerosene) or advanced fuels (electricity, LPG, biofuels).[30]

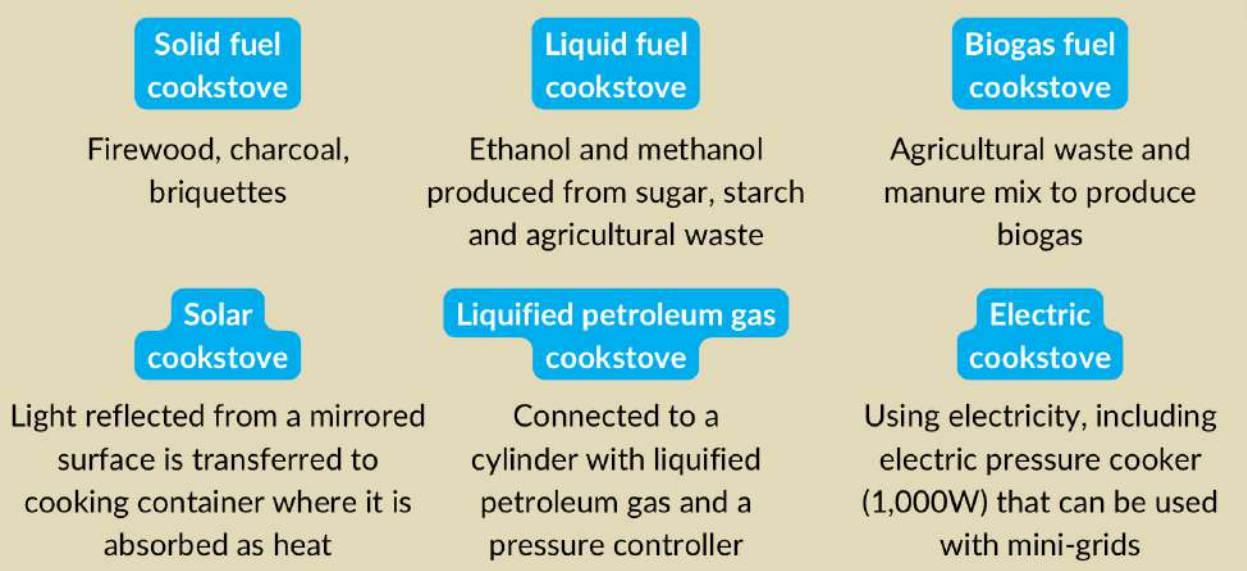
Table 4: Fuel sources for cooking

Biomass	
Firewood	Energy derived from trees or wood plants used to fuel a small fire.
Charcoal	A fuel produced by partially burning wood in a low-oxygen environment.
Briquettes	Briquettes are made through the densification of biomass, converting loose biomass into high density solid material in a variety of sizes and shapes. Biomass briquettes can be made from wood, bamboo, coffee, rice husks, corn cobs, wood shavings and straw. Briquettes can be non-carbonised or carbonised (the conversion of organic substances into carbon in the absence of oxygen).
Pellets	Small, compacted cylinders of pressed, dry biomass.
Biomass-based fuels	
Ethanol	A liquid biofuel made from materials like sugar cane, cassava, potato, maize or agricultural residues.
Biogas	A methane-rich gas produced through anaerobic digestion of organic matter such as animal dung, agricultural and kitchen waste.
Fossil fuels	
Liquefied Petroleum Gas	A by-product of natural gas and crude oil extraction, consisting of a mixture of propane and butane. It is a clean-burning, portable and efficient fuel.
Kerosene	A liquid product of crude oil, natural gas, and/or coal used for cooking, heating and lighting.
Renewable thermal energy	
Solar	Direct sunlight concentrated to direct thermal energy for heating and cooking.
Modern energy	
Electricity	Electric power generated from renewable (solar, wind, hydro, biomass) or non-renewable sources (coal, gas, oil). Electricity can be provided through the national grid, a mini-grid, or off-grid technologies.

[29] Global Alliance for Clean Cookstoves, *Guide to Cookstove Technologies and Fuels*, 2015.; World Bioenergy Association (WBA), *Factsheet: Clean and Efficient Bioenergy Cookstoves*, 2016; Energypedia, *Cooking Energy Matrix*, 2023. https://energypedia.info/wiki/Cooking_Energy_Matrix

[30] Nyukiki, E., Okello, D., Mambo, W., Mugonola, B., *Drivers of household demand for cooking energy: A case of Central Uganda*, 2022. Heliyon. 8 (3).

There are several types of cookstoves available that can be categorized by the type of fuel source:[31]



Cookstoves have varying levels of efficiency, ventilation, and safety, as measured by the MTF. On the lowest tier **is the traditional cookstove**, the "three-stone fire," where three stones are arranged in a triangle with a wood fire in the middle and a cooking pot positioned over the fire. This stove has low heat-transfer efficiency and high indoor air pollution.

An "improved cookstove" (ICS) is one that is improved in energy efficiency, fuel consumption, emissions and ventilation, or safety.[32] These include mud stoves or metal cookstoves that use charcoal, wood, briquettes, or pellets (Tier 1-3). The ICS generally have a combustion chamber and may have a chimney for ventilation. For example, the Rocket Lorena is a mud stove with two saucepan cavities and a chimney.[33] The use of improved cookstoves increases fuel efficiency, reduces the biomass collected and used, and reduces smoke and the related health impacts. ICS have been shown to reduce fuel consumption by about 20-32kg per month and reduce the time women spend collecting biomass by 92%.[34]

An advanced cookstove (ACS) is a high performing cookstove that emits low emissions. It includes forced air stoves (with a high-powered fan) or gasifier stoves that force the gases and smoke back into the cookstoves' flame until almost complete combustion has occurred. [35]

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[31] WBA, *Factsheet: Clean and Efficient Bioenergy Cookstoves*, 2016; Energypedia, *LPG for cooking*. 2022. https://energypedia.info/wiki/LPG_for_cooking#:~:text=For%20safety%20reasons%2C%20a%20LPG,and%20finally%20the%20burner%20itself.

[32] Energypedia, *Improved Cookstoves and Energy Saving Equipment*, 2022. https://energypedia.info/wiki/Improved_Cookstoves_and_Energy_Saving_Cooking_Equipment#:~:text=Cookstoves%20are%20commonly%20called%20%E2%80%9Cimproved,charcoal%2C%20agriculture%20residues%20or%20dung.

[33] Energypedia. Two Pot Rocket Lorena Uganda, 2022. https://energypedia.info/images/7/74/Draft_rocket_lorena_uganda_stove_fact_sheet-lf-ed.pdf

[34] Energypedia, *Welcome to the Water and Energy for Food Portal*, 2022. https://energypedia.info/wiki/Portal:Water_and_Energy_for_Food.

[35] Energypedia, *Improved Cookstoves and Energy Saving Equipment*, 2022. https://energypedia.info/wiki/Improved_Cookstoves_and_Energy_Saving_Cooking_Equipment#:~:text=Cookstoves%20are%20commonly%20called%20%E2%80%9Cimproved,charcoal%2C%20agriculture%20residues%20or%20dung.

Examples include bio-stoves that run on ethanol (Tier 4) and electric appliances, such as an electric pressure cooker (Tier 5).

Photo 1: Three-stone open fire

3. Energy for lighting in refugee-hosting districts

3.1 Situational overview

Access to grid electricity is low in rural areas and refugee settlements. Just over half of the total population (57%) in Uganda uses electricity for household lighting through either on-grid (19%) or off-grid (38%) connections. Rates are lower in rural areas (18%),[36] of which only 5% of households are connected to the national grid.[37] In refugee-hosting districts, only 2% of host community and 1% of refugee households are connected to the grid. The refugee-hosting districts with grid access are Kikuube, Adjumani, Kyegegwa, Kamwenge, and Isingiro.[38]

More than a third of rural households use standalone solar lighting products. In rural areas, households predominantly use electricity generated from solar kits (31%) or solar home systems (13%). Those households that do not use electricity rely mainly on dry cell battery torches (19%) or the open-wick kerosene lamps known locally as 'tadooba' (17%), followed by phone torches (9%). Relatively few use dry grass (2%) or candles (0.8%) for lighting.[39]

[36] The UN Refugee Agency (UNHCR), *Access to Clean Energy for Refugees: Uganda Case Studies*, 2022.

[37] Uganda Bureau of Statistics (UBOS), *Uganda National Household Survey. 2019/2020*, 2021.

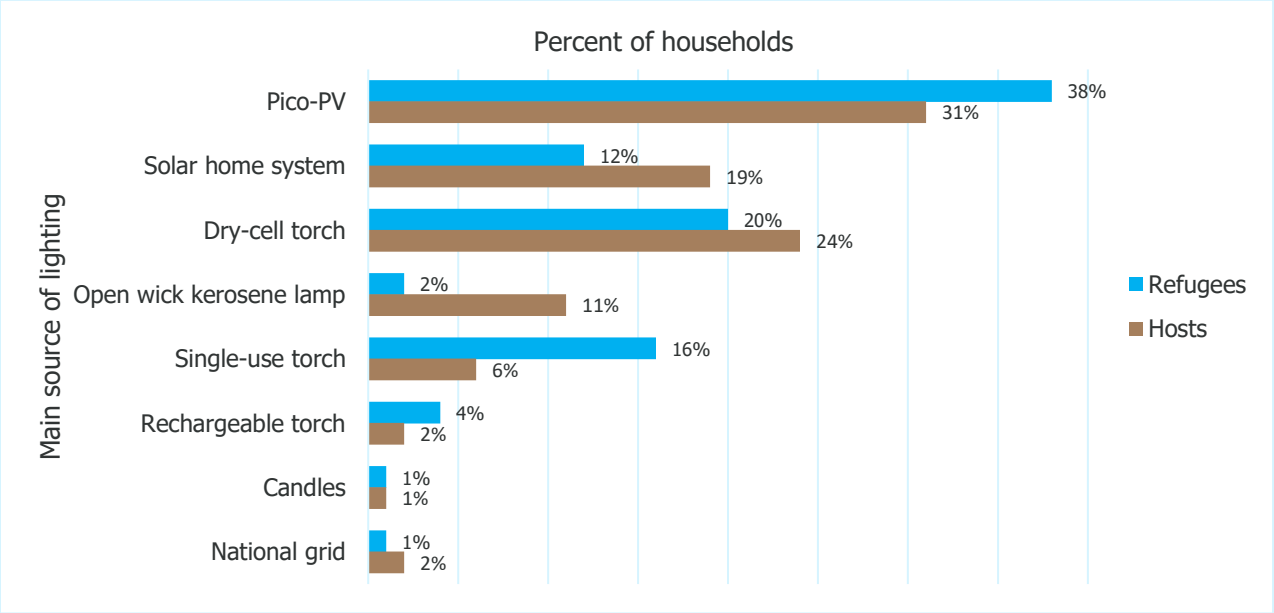
[38] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[39] UBOS, *Uganda National Household Survey. 2019/2020*, 2021

Half of refugee and host community households use off-grid standalone solar products for lighting and charging phones (see Figure 1).[40] The most common lighting products used by refugee households are pico-PV products (38%), followed by dry cell torches (20%) or single use torches (16%) that can be used for a few hours. Host communities also use predominantly pico-PV products (31%) and dry-cell torches (24%), but many also use solar home systems (19%). The use of pico-PV products is likely higher among refugees because UNHCR distributed 300,000 solar lanterns to newly arrived refugees from 2016 to 2021.[41] A higher portion of refugee households (49%) reported receiving a lighting product for free, which was generally a high quality, low-capacity single-light system (i.e., a solar lantern). In host communities, the majority of households (95%) purchased their lighting products, both pico-PV and solar home systems.[42]

Solar lanterns provide a portable source of light, which is particularly important for women and girls to improve safety and reduce instances of SGBV outdoors. However, many of the refugee households who received solar lanterns have reported that they stopped working. When solar lanterns stop functioning, they are not repaired as there are no programs to repair or recycle solar lanterns. As a result, refugees resort to buying new torches from retail shops.[43] Those that could not afford lighting products reported burning palm leaves or grass to provide light at night, especially when going to the toilet.[44]

Figure 1: Energy sources of lighting in refugee and host households in 11 refugee-hosting districts in 2022 (IFC, 2022)



[40] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[41] UNHCR, *Access to Clean Energy for Refugees: Uganda Case Studies*, 2022

[42] EnDev, *The State of Sustainable Household Energy Access in Refugee Settings in Uganda: Survey Findings in Rhino Camp Settlement and Imvepi Settlement, Arua District, West Nile Region*. GIZ, 2019.

[43] CREEC, *Final Report: Baseline Assessment for Market-based Energy Access for Scale up Projects in Refugee Settlements in Uganda*, GIZ, 2020.

[44] Energising Development (EnDev), *The State of Sustainable Household Energy Access in Refugee Settings in Uganda: Survey Findings in Rhino Camp Settlement and Imvepi Settlement, Arua District, West Nile Region*. GIZ, 2019.

Studies in refugee hosting districts found that when men were respondents, they were often the head of the household. However, overall, there were more women heads of households in refugee communities (56-80%) compared to host communities (33-62%).[45,46] Many refugee women have a role in household decision-making, including about lighting, but also have lower household incomes to purchase lighting products.

The use and availability of lighting products varies between refugee settlements and districts. Though solar products and torches are the predominant lighting products, the proportion of energy sources used varies between settlements.

Studies in select settlements and refugee hosting districts found the following refugee settlements. In the refugee-hosting districts of **Isingiro, Kiryandongo,** and **Kyegegwa,** there is a greater uptake of solar home systems. Since the majority of host households (95%) purchase their solar products, it indicates a greater ability and willingness of households in these districts to pay for solar home systems. The districts with the lowest use of solar products are **Yumbe, Moyo,** and **Koboko** (see Figure 2).[47, 48]

Photo 2: Young boy charges his solar lamp

[45] CREEC, *Final Report: Baseline Assessment for Market-based Energy Access for Scale up Projects in Refugee Settlements in Uganda*, GIZ, 2020

[46] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[47] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[48] Information on Bidibidi Refugee Settement from: Mayemba, A., *Uganda's Largest Refugee Settlement Adopts Electronic Waste Management*, 2023. https://reliefweb.int/report/uganda/ugandas-largest-refugee-settlement-adopts-electronic-waste-management#:~:text=The%20team%20uses%20household%20visits,from%20BRIGHT%2C%20repair%20the%20lanterns.

Figure 2: Source of lighting in select Refugee Settlements

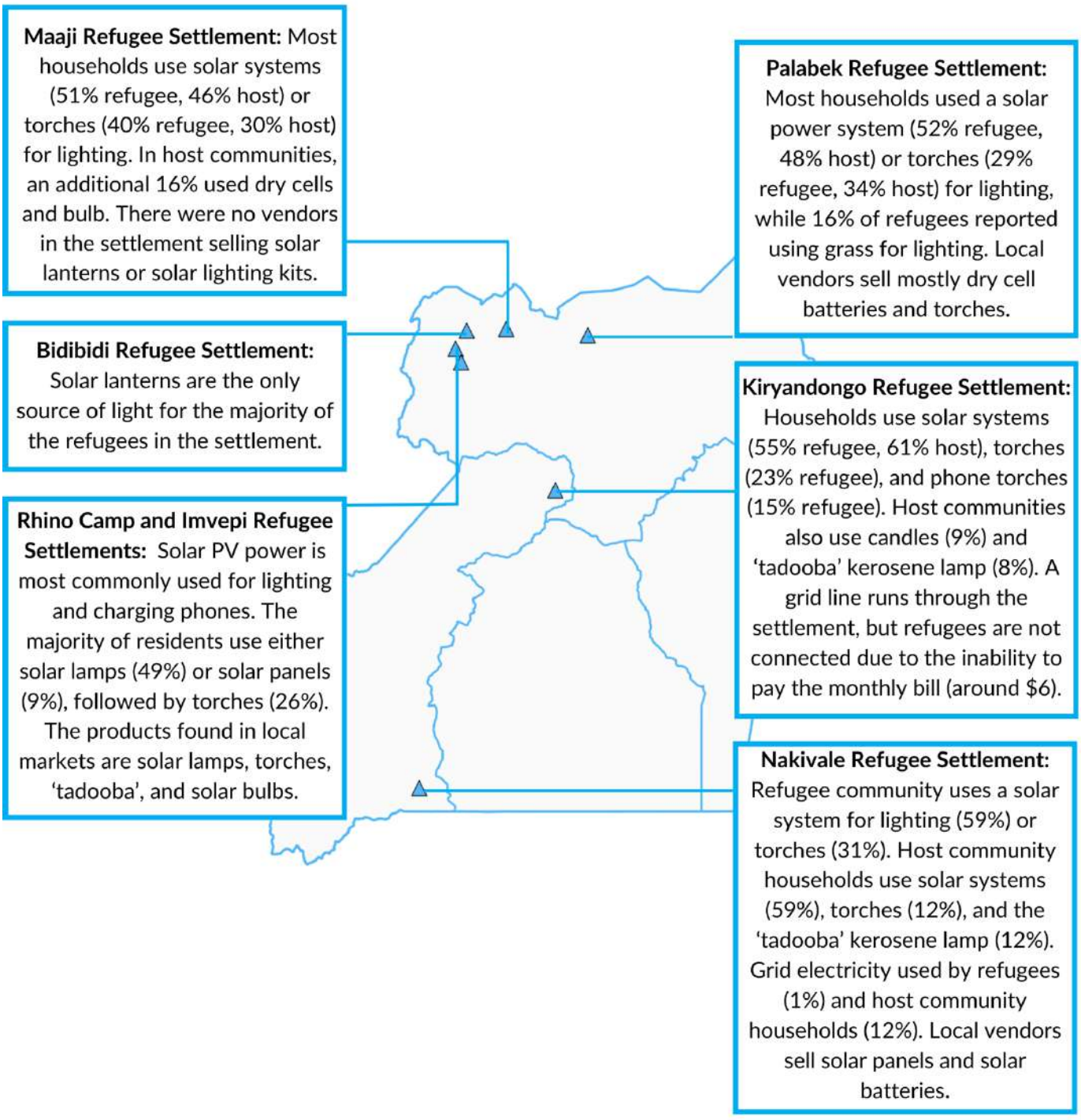
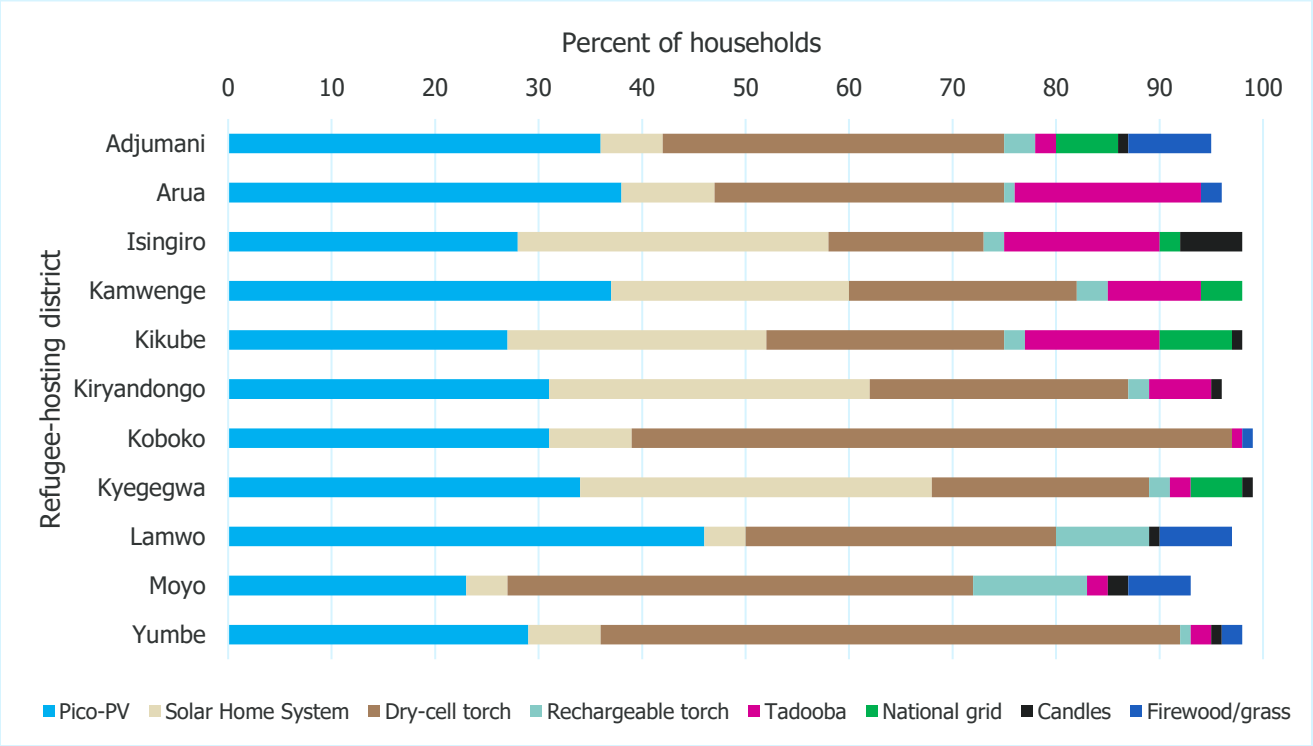


Figure 3: Main source of lighting per refugee-hosting district (percent of households) (IFC, 2022)



Solar-powered streetlights have been installed in several refugee settlements but lack maintenance. Solar-powered street lighting in refugee settlements has been found to make communities safer and reduce incidents of violence and theft.[49] Refugees settlements that have solar streetlights installed are Rhino Camp, Kyaka II[50], Kyangwali,[51] Bidibidi, Palabek, Kiryandongo, and Nakivale Refugee Settlements. In Maaji Refugee Settlement, streetlights are installed but are not operational.[52] An assessment found that 78% of the solar streetlights in the Northwest are functional, while in the Southwest only 41% are functional. The streetlights that are not functional need repair or replacement, often due to vandalism.[53] UNHCR has recommended that operation and maintenance of streetlights needs to be planned over multiple years, clarifying who will be responsible and accountable for it, and possibly having service agreements with vendors to cover maintenance and replacement costs.[54]

3.2 Challenges

A key challenge to increasing access to energy for lighting and power is affordability. The average monthly income of a refugee household is approximately $35, and $57 for host

[49] UNHCR, *How night-time street lighting affects refugee communities. A population-based assessment of community lighting in Northern Uganda's Rhino Camp refugee settlement*, 2017.

[50] Namara, E., *Green Energy Program in Uganda Fights Hunger, Protects Refugees from Sexual Assault*. Global Press Journal, 2016. https://globalpressjournal.com/africa/uganda/green-energy-program-uganda-fights-hunger-protects-refugees-sexual-assault/

[51] Power Trust, Repair works on the existing solar security lights, 2023. https://powertrusteastafrica.com/sanat_project/repair-works-on-the-existing-solar-security-lights/

[52] CREEC, *Final Report: Baseline Assessment for Market-based Energy Access for Scale up Projects in Refugee Settlements in Uganda*, GIZ, 2020.

[53] UNHCR, *Access to Services – Situational Analysis*, 2023.

[54] UNHCR. *Protection-Sensitive Access to Lighting*, 2022.

community households; this average is lower for female-headed households. Solar products have a high up-front cost which can be cost-prohibitive. A pico-PV product costs between $19 for a single-light and $40 for a multi-light system. Households with a connection to grid electricity spend an average $6.03 per month on their electricity bill.[55] The unpredictable or seasonal variation of refugee households' incomes makes it challenging to pay monthly electricity bills or to repay loans used to buy solar devices.

There is low willingness among refugee and host communities to pay for solar lighting products. In Rhino Camp and Imvepi Refugee Settlements, 70% of households were unwilling to pay cash upfront for solar lighting devices. However, many were willing to work in exchange for solar devices, to pay in instalments or use a pay-as-you-go system.[56] Another study found that around half of refugee and host communities (56%) were willing to pay for a solar home system, with the highest in Nakivale (61%) and Kiryandongo (52%) Refugee Settlements, and the lowest willingness in Maaji (40%) and Palabek (33%) Refugee Settlements.[57] The occasional distribution of free solar lanterns is also considered a barrier to engaging the private sector, as it distorts the market.[58]

There is limited availability of quality lighting products in local markets. While torches and batteries are available, the type and quality of solar products available varies between settlements. Low quality or counterfeit products are found in local markets.[59] Their substandard performance lowers consumer confidence.[60]

3.3 Initiatives

Strategies to increase energy access for rural and last mile households have focused on promoting off-grid renewable energy.[61] In rural areas and refugee-hosting districts where there is limited access to the national grid, programs have promoted the use of lower-tier off-grid products like solar lanterns, as well as solar home systems. The Energising Development (EnDev) program, for example, has supported solar companies to disseminate solar home systems and pico-PV systems for households and social institutions.[62] There are also programs that increase access to higher-tier electricity through the installation of mini-grids (solar PV or biogas). There are mini-grids installed or planned for at least four refugee settlements (see the PUE report for more information).[63]

The Government of Uganda is increasing access to energy for households through the Uganda Electricity Access Scale-Up Project (EASP). The EASP, funded by the World Bank, aims to scale-up national grid and mini-grid connectivity to last mile consumers. The EASP will increase access to renewable electricity in refugee and host communities through grid and off-grid

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[55] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[56] EnDev, *The State of Sustainable Household Energy Access in Refugee Settings in Uganda: Survey Findings in Rhino Camp Settlement and Imvepi Settlement, Arua District, West Nile Region*. GIZ, 2019.

[57] CREEC, *Final Report: Baseline Assessment for Market-based Energy Access for Scale up Projects in Refugee Settlements in Uganda*, GIZ, 2020.

[58] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[59] EnDev, *The State of Sustainable Household Energy Access in Refugee Settings in Uganda: Survey Findings in Rhino Camp Settlement and Imvepi Settlement, Arua District, West Nile Region*. GIZ, 2019.

[60] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[61] Africa Clean Energy (ACE), *Uganda Solar Water Pumping Report*, Coffey International Development Ltd,2019.

[62] Energising Development (EnDev), *Uganda*, 2022. https://endev.info/countries/uganda/

[63] MEMD, *Sustainable Energy Response Plan for Refugees and Host Communities (SERP) 2022-2025*, 2022.

technologies, as well as through the promotion of energy-efficient appliances. The project aims to extend electricity access to all refugee settlements and host communities, providing electricity to households as well as to commercial, industrial and public institutions.[64]

There are a few programs that aim to improve access to energy by addressing the barriers of affordability and availability. In refugee-hosting districts, initiatives were implemented to improve consumers' ability to purchase solar products, including though financing (supply side) and by incentivizing companies to set up operations near refugee settlements and offer demand-side subsidies. The following are three examples of approaches to increase the uptake of off-grid energy by addressing affordability and availability:

- **Direct supplier grant funding:** In this model, development partners provide funding to suppliers to set up operations near refugee settlement. The "De-Risking Pay-As-You-Go (PAYGo) Solar Home Systems in Uganda Refugee Settlements Project", implemented by Smart Communities Coalition/USAID Power Africa, aimed to stimulate market demand for solar home systems in Kiryandongo and Rwamwanja Refugee Settlements. They carried out de-risking activities with PAYGo solar house system companies by providing subsidies to establish sales offices, recruit staff, and gain access to settlements. The end-user products were not subsidized.[65]
- **Demand-side intervention:** In this model, affordability is improved by funding suppliers to reduce product prices or improve customers' access to finance. In Bidibidi Refugee Settlement, the "Accessing Markets through Private Enterprises for Refugees' Energy Access (AMPERE)" project, implemented by Mercy Corps Netherlands, partnered with private solar energy providers. A results-based financing mechanism was used to provide a 60% subsidy for clients buying small lanterns and SHS through the solar energy companies, increasing the ability to pay and reducing credit risk for suppliers.[66]
- **Blended supply-side and demand-side subsidies:** The "Energy Solutions for Displaced Settings (ESDS)" program, implemented by GIZ takes a market-based approach to improving access to electricity in Imvepi, Rhino Camp, Bidibidi and Palorinya Refugee Settlements, working on both the supply and demand side. The program simulates demand by raising awareness of technologies. Demand-side subsidies are channelled through companies, who reduce the price of solar products for end users in refugee settlements. Supply is increased by supporting private sector companies to increase production and establish supply and distribution chains in refugee settlements using results-based financing. The program supports the establishment of energy kiosks

[64] The World Bank. 2021. Project Information Document. Uganda Electricity Access Scale-up Project (EASP). https://documents1.worldbank.org/curated/en/722961612536168002/pdf/Project-Information-Document-Uganda-Electricity-Access-Scale-up-Project-EASP-P166685.pdf

[65] Moncada, A., Ruiz, L., Meyer, M., Surya, R., Wanyahoro, W. 2022. Assessment of Market-Driven Solutions: Energy Access in Refugee Settlements in Sub-Saharan Africa. Smart Communities Coalition. Smart Communities Coalition. https://www.mastercard.us/content/dam/public/mastercardcom/na/global-site/public-sector/other/scc-whitepaper.pdf; UNHCR, *Access to Clean Energy for Refugees: Uganda Case Studies*, 2022.

[66] Moncada, A., Ruiz, L., Meyer, M., Surya, R., Wanyahoro, W. 2022. Assessment of Market-Driven Solutions: Energy Access in Refugee Settlements in Sub-Saharan Africa. Smart Communities Coalition. Smart Communities Coalition. https://www.mastercard.us/content/dam/public/mastercardcom/na/global-site/public-sector/other/scc-whitepaper.pdf; UNHCR, *Access to Clean Energy for Refugees: Uganda Case Studies*, 2022.

to sell high-quality energy products and provide services like phone charging and secretarial services.[67]

4. Energy for cooking in refugee-hosting districts

4.1 Situational overview

Wood energy is the primary source of energy for cooking for 94% of the Ugandan population. Two-thirds of wood energy comes from unprocessed firewood and one-third comes from charcoal. Charcoal is used primarily by the urban and peri-urban population, while firewood is the main fuel source in rural households. Liquified petroleum gas and kerosene are used by a very small percentage of households in Uganda (below 0.5% each).[68] Only 1% of the population have access to clean cooking (electricity).[69]

The majority of refugee and host community households (99%) rely on wood biomass (firewood and charcoal) for cooking.[70] Most households use firewood (85%), followed by charcoal (14%).[71] The persistent reliance on wood fuel is due to cultural preference, its low or

Photo 3: Charcoal is put in a bag to be sold

[67] Moncada, A., Ruiz, L., Meyer, M., Surya, R., Wanyahoro, W. 2022. Assessment of Market-Driven Solutions: Energy Access in Refugee Settlements in Sub-Saharan Africa. Smart Communities Coalition. Smart Communities Coalition. https://www.mastercard.us/content/dam/public/mastercardcom/na/global-site/public-sector/other/scc-whitepaper.pdf; UNHCR, *Access to Clean Energy for Refugees: Uganda Case Studies*, 2022.

[68] Nyukiki, E., Okello, D., Mambo, W., Mugonola, B., *Drivers of household demand for cooking energy: A case of Central Uganda*, 2022. Heliyon. 8 (3).

[69] UNHCR, *Access to Clean Energy for Refugees: Uganda Case Studies*, 2022.

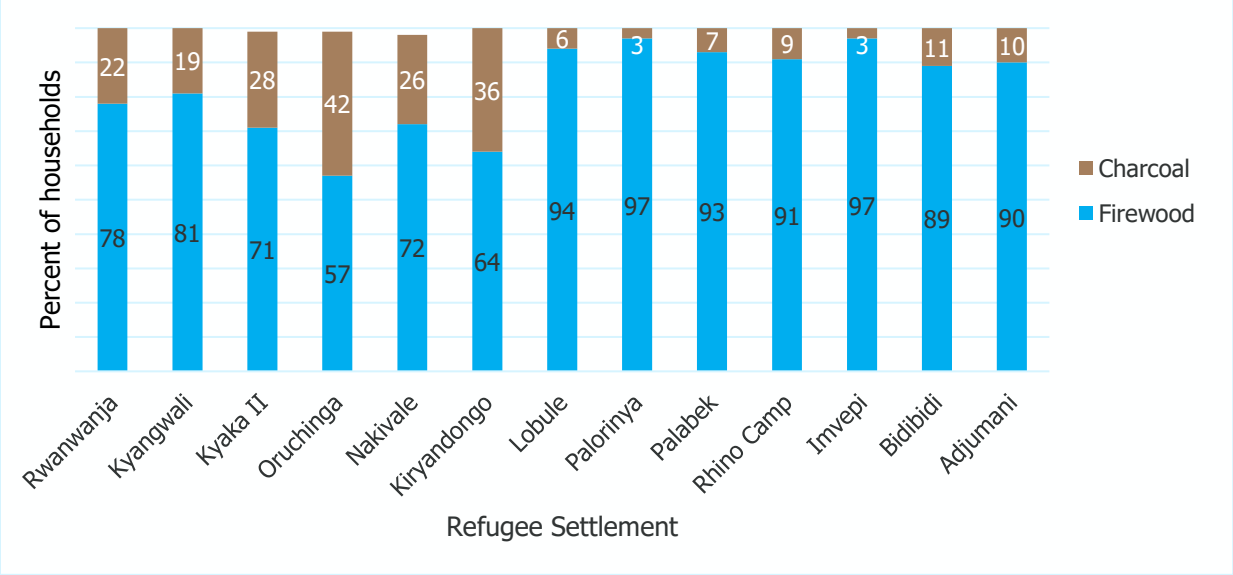
[70] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[71] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

no cost, and availability compared to other energy alternatives.[72] Refugee households predominantly use firewood, especially in northern Uganda (see Figure 4).[73] Overall, host communities are also more likely to use firewood as their primary energy source for cooking. More refugee households (22%) than host community households (11%) use charcoal, particularly where host communities restrict refugees' access to forests. Refugee households in Oruchinga and Kiryandongo Refugee Settlements have the highest charcoal use.[74]

The majority of refugee households collect firewood (85%), while few purchase it (13%). An additional 2% both collected and purchased firewood.[75] Households that purchase fuel spend on average $2.66 weekly on charcoal and $2.30 weekly on firewood, which represents about 22% of their monthly household income.[76]

Figure 4: Fuel consumption by refugee settlement (CREEC, 2018)



Women are tasked with collecting firewood in the majority (70%) of both refugee and host community households, followed by girls (14%).[77] The average walking time to collect firewood is between 1.5-2 hours, walking 4-10 km.[78] In 2018, 62% report that the distance walked to collect firewood had increased over the last year, mainly due to the unavailability of firewood. The settlements with the greatest reports of increased walking distance are Adjumani, Lobule and Imvepi Refugee Settlements in Northern Uganda where there is more deforestation.[79] Increased distance and time to collect firewood expose women and girls to greater risk of

[72] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[73] CREEC, *The environmental impact of settling refugees in refugee hosting areas in Uganda*, 2018.

[74] CREEC, *The environmental impact of settling refugees in refugee hosting areas in Uganda*, 2018.

[75] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[76] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[77] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[78] UNHCR, *Access to Clean Energy for Refugees: Uganda Case Studies*, 2022; CREEC, *The environmental impact of settling refugees in refugee hosting areas in Uganda*, 2018.

[79] CREEC, *The environmental impact of settling refugees in refugee hosting areas in Uganda*, 2018.

SGBV. It also reduces their time to spend on educational, productive or income generating activities, which reinforces gender and income inequality.

Three-stone open fires are used in the majority of host community households (76%) and nearly half of refugee households (46%).[80] Three-stone open fires have low efficiency (10-17%), use a lot of firewood and generate unhealthy amounts of smoke.[81] The second most common are mud wood stoves, with greater use in refugee households (41%) than in host community households (19%).[82] Manufactured charcoal stoves, which are more efficient, are owned by few host community (5%) and refugee (7%) households.[83] Overall, the use of improved cookstoves in the 13 settlements varies between 24%-61%, with the greatest use in Kiryandongo, Kyangwali, and Kyaka II Refugee Settlements.[84]

Fuel stacking is common in refugee settlements. More than a third of households (34%) report using two cooking technologies, and 1.2% used three technologies.[85] Households with two or more cooking technologies (18%[86]-34%) generally have a combination of a mud wood stove, mud charcoal stove, metal charcoal stove, or three-stone open fire.[87]

The majority (90%) of refugees and hosts make their own stoves (three-stone open fire or mud stoves) rather than buy them. The 6% who purchase stoves choose metallic charcoal stoves, manufactured charcoal stoves and mud stoves. An additional 4% have received stoves for free.[88] In Rhino Camp Refugee Settlement and Imvepi Refugee Settlement, the majority of households with improved cookstoves had received them for free from development partners.[89]

The availability of wood influences fuel choices. Where firewood is available for free or low cost, like in Palabek Refugee Settlement, it is the predominant energy source. In Bidibidi Refugee Settlement, only 12% of households purchase firewood because most can collect wood in nearby woodland.[90] Where forests are on host community land, refugees may be denied access to collect firewood, such as in Rhino Camp and Imvepi Refugee Settlements. In this case, refugees buy firewood or barter for it in exchange for porridge, flour, beans, or maize.[91]

4.2 Improved cookstove (ICS) and fuels

There are several types of cookstoves that are produced and/or promoted in Uganda (see Table 3). A study in four refugee settlements found the most common stoves sold by vendors was the

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[80] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[81] Kay, S., Duguma, L., and Okia, C., *The potentials of technology complementarity to address energy poverty in refugee hosting landscapes in Uganda*, 2021. Energ. Ecol. Environ. 6(5): 395-407.

[82] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[83] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[84] CREEC, *The environmental impact of settling refugees in refugee hosting areas in Uganda*, 2018.

[85] CREEC, *Final Report: Baseline Assessment for Market-based Energy Access for Scale up Projects in Refugee Settlements in Uganda*, GIZ, 2020.

[86] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[87] CREEC, *Final Report: Baseline Assessment for Market-based Energy Access for Scale up Projects in Refugee Settlements in Uganda*, GIZ, 2020.

[88] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[89] Energising Development (EnDev) Uganda. 2018. Piloting Energy Access in Refugee Settlements and Host Communities to Create Evidence for Market-Based Approaches. GIZ. Germany.

[90] GIZ, *Potentials of Biomass Cooking Fuel Production in Displacement Settings*, 2022.

[91] EnDev, *The State of Sustainable Household Energy Access in Refugee Settings in Uganda: Survey Findings in Rhino Camp Settlement and Imvepi Settlement, Arua District, West Nile Region*. GIZ, 2019.

SmartHome stove (a clay-lined metal clad stove) and stoves made by local artisans (ceramic charcoal stove, mud stove, and metallic charcoal stove). Development partners have trained local artisans to build the Rocket Lorena stove to increase accessibility in refugee-hosting areas.[92]

Table 3: Improved and advanced cookstoves promoted in Uganda

Stove	Description	Efficiency	Promotion
Rocket Lorena Stove	A fixed two-pot stove for firewood with a chimney and single fuel feed and combustion chamber.	50-60% less firewood	LWF is promoting the Rocket Lorena stove in Palorinya, Adjumani, and Palabek Refugee Settlements; International Centre for Research in Agroforestry (ICRAF) supports women to construct Rocket Lorena in Rhino Camp and Imvepi Refugee Settlements.
SmartHome	Clay-lined metal clad charcoal cookstove that emits little smoke.	50% less charcoal consumption	UpEnergy produces and distributes the SmartHome stove; sold by vendors in various settlements.
UGASTOVE domestic charcoal stove	Locally produced improved cookstoves with a ceramic inner liner and produce less smoke.	50% less charcoal consumption	Impact Carbon supports local manufacturing partners to make and market the stove.
Amawu Stove	Micro-gasifier stove using a variety of solid biomass fuels, such as agricultural waste, and makes charcoal as a by-product.	90% smoke-free	Nearly 6,000 stoves sold in peri-urban and rural households.
Eco Smart charcoal or firewood stove	Charcoal stove with a metallic casing and a combustion chamber made of organic material.	35% thermal efficiency; 45% less charcoal used	EcoSmart is sold through results-based financing in Kiryandongo, Rhino Camp, Imvepi and Bidibidi Refugee Sentiments.
BM Stoves	Metal charcoal stoves, baking ovens, and institutional cookstoves.	45% less fuel used	BM Energy Saving Equipment are selling stoves in the West Nile area, including in refugee settlements.
Clean Environment for Africa Uganda (CEFA) Stoves	Energy saving cookstoves for domestic and institutional use.	50% less wood and charcoal	CEFA is selling stoves in the West Nile area under results-based financing.
Mubende Stoves	Metal charcoal stoves	N/A	Mubende Stoves are sold in Rwamanja Refugee Settlement.
Mandulis Energy gasifier stove	A clean gasifier stove	N/A	Stove is distributed with cooking briquettes in Adjumani, Kiryandongo and Lamwo Refugee Settlements.
ECOCA solar electric cooker	A compact, self-contained home cooking unit run by solar energy that does not produce smoke or CO^2. It contains an electric base, a battery pack and solar panel. It can also be used to charge phones.	No emissions	Pesitho and Mercy Corps subsidized the purchase of the cookers to households in Bidibidi Refugee Settlement.

[92] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

ACE One	Solar-biomass hybrid energy system using electrical and thermal energy, emitting a negligible level of smoke. It can burn any dry solid biomass fuel (animal waste, crop residue, small sticks). It includes an LED lamp and solar panel; it can charge phones.	50-85% less fuel	Africa Clean Energy (ACE) Uganda has offices in Mbale, Gulu, and Fort Portal. With CARE, ACE is promoting stoves in Kyangwali Refugee Settlement.
Electric Pressure Cooker (EPC)	Ultra-efficient electric cooker that traps heat and allows cooking to be completed using minimal electricity.	60% less time cooking; 50% savings on fuel costs	UpEnergy produces and distributes EPCs. Modern Energy Cooking Services (MECS) and the Ministry of Energy and Mineral Development promoting EPCs.

Briquettes have potential as a biomass-based alternative to firewood but there is low awareness and adoption. Briquettes can be made using raw materials like maize, cereals, roots, cane sugar, coffee residues, or organic waste. In Nakivale Refugee Settlement, very few refugee households (1.7%) uses briquettes, which are produced by local groups trained by UNHCR.[93] Additionally, the quality of the briquettes remains poor, they are more expensive than firewood, and demand is low. There are efforts to expand the production, distribution, and uptake of different briquettes, including the following:

- **Non-carbonised briquettes:** Mandulis Energy operates a briquette-making machine that produces non-carbonised briquettes from agricultural processing residues. The company is working with development partners to distribute and sell non-carbonised briquettes and gasifier cookstoves in Adjumani, Kiryandongo, and Lamwo Refugee Settlements. Families were trained to use the gasifier cookstoves to convert biomass briquettes into biochar to use as an organic fertilizer.
- **Char briquettes:** Danish Church Aid (DCA) has supported briquetting groups (mainly women) in Rhino Camp, Imvepi and Bidibidi Refugee Settlements to make hand-pressed char briquettes to sell within the settlement. Refugee groups were provided a carboniser, mixer, honeycomb press, stick press, production shelter, and drying racks. Groups in each settlement produce briquettes from carbonised maize and cassava stalks and bind it with clay, cow dung or cooked cassava flour.[94]
- **Manufactured char briquettes:** Adapt+ is a social enterprise that mass produces low-cost char briquettes to sell to vulnerable groups and refugees. There is a facility at Kyaka II Refugee Settlement where they carbonise maize cobs (plus sometimes maize stalks, bean stalks & groundnut shells), which is milled and blended with a binder (usually molasses, sometimes cassava flour) and densified into cylindrical or pillow-shaped briquettes.[95]
- **Bamboo briquettes:** Divine Bamboo is a social enterprise producing and promoting bamboo-based briquettes, which have a higher calorific (heating) value than traditional charcoal and firewood. Produced from fast-growing bamboo, they can reduce household fuel expenditures by 50%. Divine Bamboo is produced in Kisoro and Kabale districts, but

[93] CREEC, *Final Report: Baseline Assessment for Market-based Energy Access for Scale up Projects in Refugee Settlements in Uganda*, GIZ, 2020

[94] GIZ, *Potentials of Biomass Cooking Fuel Production in Displacement Settings*, 2022.

[95] GIZ, *Potentials of Biomass Cooking Fuel Production in Displacement Settings*, 2022.

also has a briquette distributorship training program to spur entrepreneurship and scale up distribution in different areas of Uganda.[96]

- **Briquette-making groups**: Nsamizi Training Center, supported by UNHCR, trains refugees to make charcoal briquettes using a press. Nsamizi buys briquettes from the producer groups to distribute to vulnerable groups in Kyangwali, Kyaka II, Rwamwanja, Nakivale, and Oruchinga Refugee Settlements.[97] Producer groups, primarily women, have been supported to develop briquettes in Kyaka II (SAFE program),[98] Rhino Camp and Imvepi Refugee Settlements (ICRAF),[99] and Kiryandongo and Koboko Refugee settlements (Humanitarian Assistance & Development Services).[100]

Biogas is a clean fuel option, but its adoption in Uganda is low. Biogas provides a cheaper and smoke-free alternative to firewood. The main material used for biogas generation in Uganda is cow dung. The Netherlands Development Organization SNV has supported the adoption of small-scale household biodigesters to create biogas from cow dung and a bio-slurry used for fertilizer.[101] Over 7,600 households have constructed biogas digesters, a standalone system that transforms organic waste into cooking gas. The use of a biogas stove reduces the time spent preparing meals, eliminates the need to collect wood and improves health in a smoke-free environment, which greatly benefits the women and girls who spend their time on these domestic chores.[102] The adoption of biogas is limited due to the high upfront costs, the inability to repair the biodigesters when they break, and the need for a continuous supply of fuel (dung).[103] In many refugee-hosting districts, the issue of affordability and insufficient livestock production are limitations to its adoption.[104]

Electric cooking in Uganda has potential but faces various hurdles. Electricity-based cooking (e-cooking) can be done with grid and off-grid systems. There are cooking devices that work on mini-grids and home systems, such as the electric pressure cooker.[105] There are also solar-powered options, such as the ECOCA solar electric cooker. Electric cooking provides a viable path to reducing biomass use in Uganda. However, the main barriers include low awareness, supply constraints, the cost of the

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[96] Sustainable Energy for All (SEforAll), *Divine Bamboo creating local market for clean cooking in Uganda*, 2020. https://www.seforall.org/stories-of-success/divine-bamboo-creating-local-market-for-clean-cooking-in-uganda

[97] CREEC, *Final Report: Baseline Assessment for Market-based Energy Access for Scale up Projects in Refugee Settlements in Uganda*, GIZ, 2020; GIZ, *Potentials of Biomass Cooking Fuel Production in Displacement Settings*, 2022.

[98] Namara, E., *Green Energy Program in Uganda Fights Hunger, Protects Refugees from Sexual Assault*. Global Press Journal, 2016.

[99] GIZ, *Potentials of Biomass Cooking Fuel Production in Displacement Settings*, 2022.

[100] GIZ, *Potentials of Biomass Cooking Fuel Production in Displacement Settings*, 2022.

[101] Habersbrunner, K., Mirembe, A., Ruhlemann, A., *Affordable, Empowering and Sustainable Decentralized Renewable Energy Solutions: Potentials of energy communities in Uganda*, 2018.; SNV, *Biogas Project in Uganda celebrates milestone completion*, 2023. https://www.snv.org/update/biogas-project-uganda-celebrates-milestone-implementation

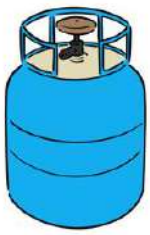
[102] SNV, *What Energy Means to Ugandan biogas users*, 2017. https://www.snv.org/update/what-energymeans-ugandan-biogas-users

[103] Ogwok, J., Naluwagga, A., Abbo, M., Tesfamichael, M., *Uganda's cooking energy sector: A review*. Modern Energy Cooking Services (MECS), 2022.

[104] Kay, S., Duguma, L., and Okia, C., *The potentials of technology complementarity to address energy poverty in refugee hosting landscapes in Uganda*, 2021. Energ. Ecol. Environ. 6(5): 395-407.

[105] MECS, *Accelerating Access to Electric Cooking*, 2022.

technologies and electricity tariffs, and the perception that it gives food a different taste to traditional dishes.[106] Many of the existing electric cooking products are inefficient and consume a lot of electricity, which translates into high electricity bills.[107] As Uganda increases its capacity to generate electricity, especially through mini-grids, there is potential to increase use of electricity for cooking using high-efficiency appliances.[108] In refugee settlements, households are not cooking with electricity.[109] However, the use of the ECOCA stove was piloted in Bidibidi Refugee Settlement.



Liquified Petroleum Gas (LPG) is promoted in Uganda but has limitations. It can be considered a transitional fuel to encourage households to move to cleaner and more modern energy sources. Though it is cleaner than wood energy, LPG is non-renewable and is imported from other countries. It has an unreliable supply, especially outside of urban areas due to a low demand and a weak supply chain. It has relatively high prices and requires an LPG cookstove.[110] The use of LPG for cooking is minimal and the awareness of LPG is low.[111] The supply of LPG in refugee settlements is limited.[112] Nakivale is the only settlement reporting LPG use and with vendors in the settlement reporting sales.[113] There is also a program led by the Raising Gadbo Foundation piloting the sale of LPG to urban refugees, providing a subsidy of 50% to both refugee and host communities.[114]

Solar energy can be used for water purification, heating, and pumping. Solar energy provides an alternative to boiling water with wood energy. In Kyangali Refugee Settlement, 25,000 SolarSacks were distributed in 2020 for household water treatment. The initiative reached over 7,800 households, the majority of which showed an improvement in health from reduced water-borne diseases.[115] Solar water heating systems are also available. They are cheaper than SHS, but not as common. The system produces hot water that can be used for cooking, reducing the fuel input required.[116] Furthermore, solar water pumps can help to facilitate access to water for cooking and consumption. These pumps have been installed in Palabek, Bidibidi, and Rhino Refugee Settlements.[117]

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[106] Ogwok, J., Naluwagga, A., Abbo, M., Tesfamichael, M., *Uganda's cooking energy sector: A review*. Modern Energy Cooking Services (MECS), 2022.

[107] Ogwok, J., Naluwagga, A., Abbo, M., Tesfamichael, M., *Uganda's cooking energy sector: A review*. MECS, 2022.

[108] Ogwok, J., Naluwagga, A., Abbo, M., Tesfamichael, M., *Uganda's cooking energy sector: A review*. MECS, 2022.

[109] MECS, *Accelerating Access to Electric Cooking*, 2022.

[110] Price, R., *"Clean" Cooking Energy in Uganda – technologies, impacts, and key barriers and enablers to market acceleration*, Institute of Development Studies, 2017.

[111] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[112] MEMD, *Sustainable Energy Response Plan for Refugees and Host Communities (SERP) 2022-2025*, 2022.

[113] Modern Energy Cooking Services (MECS), *Accelerating Access to Electric Cooking*, 2022.

[114] Grafham, O., Lahn, G., and Haselip, J., *Scaling sustainable energy services for displaced people and their hosts. Chatham House*, 2022.

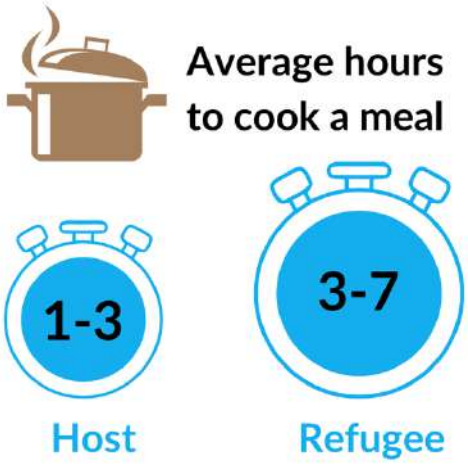
[115] Caritas Denmark and SolarSack, *Impact Evaluation Report for the Project Emergency Response to Deforestation Crisis of the Kyangwali Refugee Settlement*. SolarSack, 2021.

[116] Kay, S., Duguma, L., and Okia, C., *The potentials of technology complementarity to address energy poverty in refugee hosting landscapes in Uganda*, 2021. Energ. Ecol. Environ. 6(5): 395-407.

[117] Grafham, O., Lahn, G., and Haselip, J., *Scaling sustainable energy services for displaced people and their hosts. Chatham House*, 2022.

4.3 Challenges

There is low willingness to pay for improved cookstoves (ICS) or alternative fuels, especially where firewood is available for free.[118] Fuel purchase is challenging for refugees as it represents a high portion of the low household income. When surveyed, approximately 40% of respondents are willing to pay for improved cookstoves, with a higher response rate among host community members compared to refugees.[119] In Rhino Camp and Imvepi Refugee Settlements, nearly half of refugees (48%) are willing to purchase ICS if they cost less than UGX5,000. In regions like West Nile, there is low willingness to pay for cooking fuels because of the availability of free firewood within walking distance.[120] Charcoal continues to be used less than firewood because it is more expensive and requires a different cookstove.



Women are more willing to adopt improved or modern cooking technologies, but men generally hold the household decision-making power.[121] The majority of cooking is done by women (94.5%) in both refugee and host communities. It takes between 1-3 hours to prepare a meal in host communities, and 3-7 hours per meal in refugee communities due to the use of inefficient stoves. Female-headed households are more aware of the benefits of alternative fuels and improved cookstoves, such as reduced time spent cooking and less smoke, and are more willing to adopt new technologies. Although women may be willing to adopt new cooking technologies, the financial decisions tend to be made by men.[122] As men are not part of the cooking process, they do not prioritize the benefits of new cooking technologies enough to make the investment. When women are in charge of both cooking and household finances, or are involved in the briquette making process, they are more likely to purchase briquettes or other modern cooking technologies.[123]

There is limited availability of improved cookstoves or alternative fuels in refugee-hosting districts. Only 6% of businesses surveyed in refugee-hosting districts sell ICS. Higher-tier stoves are not accessible in many refugee-hosting areas in the West Nile area, such as Maaji and Palabek Refugee Settlements. Briquettes are not available in all refugee settlements, except where there are local groups trained to produce briquettes manually. Clean alternatives, like LPG, are not widely available in refugee settlements.[124] The supply chain for energy products is weak, there is poor road infrastructure to remote locations, and suppliers do not have facilities

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[118] GIZ, *Potentials of Biomass Cooking Fuel Production in Displacement Settings*, 2022.

[119] CREEC, *Final Report: Baseline Assessment for Market-based Energy Access for Scale up Projects in Refugee Settlements in Uganda*, GIZ, 2020.

[120] GIZ, *Potentials of Biomass Cooking Fuel Production in Displacement Settings*, 2022.

[121] Elasu, J., Ntayi, JM, Adaramola, M., Buyinza, F., Ngoma, M., and Atukunda, R. Gender role differentiation in household fuel transition decision-making: Implications for education and training in Uganda. Frontiers in Sustainability. 22 February 2023 https://www.frontiersin.org/articles/10.3389/frsus.2023.1034589/full.

[122] Ogwok, J., Naluwagga, A., Abbo, M., Tesfamichael, M., *Uganda's cooking energy sector: A review*. MECS, 2022.

[123] Nyukiki, E., Okello, D., Mambo, W., Mugonola, B., *Drivers of household demand for cooking energy: A case of Central Uganda*, 2022. Heliyon. 8 (3).

[124] Ogwok, J., Naluwagga, A., Abbo, M., Tesfamichael, M., *Uganda's cooking energy sector: A review*. MECS, 2022.

near refugee settlements.[125] The limited availability combined with high prices hinder the adoption of ICS and cleaner fuels.[126]

Rather than replacing traditional energy options, households practice fuel stacking. As more efficient options become accessible, households add these new technologies without ceasing the use of inefficient traditional methods. As a result, challenges of deforestation and respiratory illnesses caused from traditional methods persist. While modern cooking technologies are an option, the uncertainty in electricity access and the perceived change of flavour in traditional dishes will limit the ability to completely replace traditional fuels with electric options.[127] Finally, refugees have less land to produce their own wood. The size of plots allocated to the growing number of refugees has decreased from 100 square metres to less than 30 square metres. This is too small to produce a sustainable supply of firewood for cooking.[128]

Photo 4: Patience, 32, makes lunch for her extended family using charcoal

[125] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[126] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[127] Ogwok, J., Naluwagga, A., Abbo, M., Tesfamichael, M., *Uganda's cooking energy sector: A review*. MECS, 2022.

[128] Grafham, O., Lahn, G., and Haselip, J., *Scaling sustainable energy services for displaced people and their hosts. Chatham House*, 2022.

5. Conclusions and recommendations

Energy is essential for households in displaced settings to meet basic needs, particularly lighting and cooking. Energy access is a multi-dimensional issue, influenced by factors such as the availability, efficiency, quality, affordability and the safety of the energy source.

In refugee-hosting districts, households have little access to electricity from the national grid. Nearly half of households use off-grid standalone solar products for lighting, with more refugee households using pico-PV products and more host community households using solar home systems. The remaining households rely on low-tier battery-powered and fuel-based lighting. To improve access to electricity, there are strategies to distribute solar energy products, address supply and demand-side barriers to access, and generate off-grid electricity through mini-grids.

Nearly all households rely on wood biomass for cooking and the "three-stone open fire" is the most common stove used. There is a higher uptake of improved cookstoves in refugee households than host communities, but it is also common to practice fuel stacking with two or more types of cookstoves found in a household. The uptake of improved cooking technologies and alternative fuels is hindered by issues of availability, affordability, and gender roles in decision-making.

While the use of more efficient stoves reduces the amount of wood biomass used, these savings are offset by the population growth in refugee-hosting districts. The growing scarcity of wood increases the distance to collect wood, exposing women and girls to SGBV, and increases the risk of conflict between refugee and host communities. Furthermore, although ICS have been found to reduce respiratory symptoms and infections, the indoor household air pollution levels remain above WHO air quality guidelines, possibly due to long cooking times.[129]

The literature review highlighted several general recommendations to improve energy access in refugee settlements:

1) Encourage the adoption of more efficient cooking technologies, while increasing access to cleaner fuels over the long term. Support the transition to ICS and alternative fuels while enhancing the enabling environment for electricity access. [130]

2) Promote the consistent use of clean alternatives in order to displace traditional fuels and stoves and discourage fuel stacking, which prolongs the use of inefficient methods.

3) Take a market-based approach to improving energy access. Rather than offering products for free, which can distort the market, create the conditions for consumers to purchase improved lighting and cooking technologies.

4) Take a holistic approach to lighting and cooking, particularly in areas where the national grid or mini-grids are extended. Focus on improving electricity access for both purposes, encouraging the adoption of e-cooking. E-cooking reduces the demand for wood biomass, reducing the environmental impact, health problems, and SGBV. This way,

[129] Van Gemert, F., et. al., *Effects and acceptability of implementing improved cookstoves and heaters to reduce household air pollution: a FRESH AIR study*. Primary Care Respiratory Medicine, 2019; Ogwok, J., Naluwagga, A., Abbo, M., Tesfamichael, M., *Uganda's cooking energy sector: A review*. MECS, 2022.

[130] GIZ, *Potentials of Biomass Cooking Fuel Production in Displacement Settings*, 2022.

households can leapfrog the energy transition from biomass directly to modern energy for cooking, skipping a transitional step of improved cooking fuel and cookstoves.[131]

5) Integrate a gender equality and women's empowerment angle into energy programming. Access and adoption of energy solutions can vary by gender due to roles in the household and financial decision-making. Collect and analyse gender-disaggregated data to understand the gendered challenges to energy access, develop targeted approaches, and engage women in the energy economy.

6) Increase the supply of wood biomass while also decreasing demand. Support the growth of more trees through agroforestry (growing trees on agricultural fields), afforestation (establishing a forest where there was no recent tree cover), and reforestation (replanting deforested areas).[132]

7) Strengthen coordination between key actors in refugee-hosting districts.[133] Humanitarian agencies, NGOs, government and private sector actors can coordinate efforts to improve household access to energy and develop a strong market and supply chain for priority energy products. Work with Uganda National Bureau of Standards (UNBS) to adopt, enforce and raise awareness of quality standards of solar products.

There are a number of initiatives being implemented to increase household access to energy and that address key challenges, such as availability, affordability, and willingness to pay. Actions that can be continued and scaled up include:

1) Increase the availability of improved cookstoves. Train local artisans to produce ICS to sell in local markets. Raise awareness of the benefits of using ICS to encourage uptake.

2) Increase the demand for and supply of alternative fuels that are not derived from wood biomass and support their adoption.[134] Fuels that are not derived from wood biomass include briquettes made from bamboo or crop residues like straws, stems, leaves, husks, shells. Support the local production of the briquettes and the supply chain to make these available in refugee settlements.

3) Improve briquette quality. Support the move from handmade briquettes to a mechanized briquetting process to have more consistent quality, greater cost efficiency, and lower price to better compete with charcoal. Establish a supply chain with storage depots and transportation to reach refugee settlements.[135]

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[131] Ogwok, J., Naluwagga, A., Abbo, M., Tesfamichael, M., *Uganda's cooking energy sector: A review*. MECS, 2022.

[132] Kay, S., Duguma, L., and Okia, C., *The potentials of technology complementarity to address energy poverty in refugee hosting landscapes in Uganda*, 2021. Energ. Ecol. Environ. 6(5): 395-407.

[133] IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[134] Global Platform for Action (GPA), Access to Energy for Cooking in Displacement Settings, 2023. https://www.humanitarianenergy.org/news/latest/access-to-energy-for-cooking-in-displacement-settings; IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[135] GIZ, *Potentials of Biomass Cooking Fuel Production in Displacement Settings*, 2022.

4) Promote the use of e-cooking. Solar e-cooking is an increasingly viable option for displacement settings without grid access. Electric pressure cookers are a viable option where there is off-grid and grid electricity access. Raise awareness of e-cooking through demonstrations to show the savings in cost and time without compromising flavour.

5) Strengthen the supply chain of quality solar lighting products, improved cookstoves and alternative fuels. Incentivize local providers to establish inventory and sales hubs in or near refugee settlements.[136] Support the installation of energy kiosks or similar hubs and facilitate connections with suppliers.

6) Provide demand-side subsidies. Use results-based financing to provide subsidies to energy providers who in turn will offer quality energy products at a reduced price for consumers.

7) Improve consumer access to flexible financing. Work with providers to allow payments in instalments or pay-as-you-go options to purchase energy products. Help establish village savings and loans associations to access credit to purchase improved energy products.

8) Engage refugees, particularly women, to engage in energy businesses and value chains. Energy products were more often sold by vendors in host communities, rather than refugee settlements.[137] Provide training to equip energy vendors and entrepreneurs in refugee settlements, including women, with necessary skills to run an energy-related business. Support women in the production of briquettes and ICS.[138] Support entrepreneurship to sell, install, repair, and recycle energy products.

9) Raise awareness of the benefits of improved cooking technologies and fuels among both men and women.[139] To increase adoption, target both men and women in awareness and education campaigns, showing the benefits relating to the time and monetary savings, health, and efficiency. Promote social and behavioural change relating to cooking and the management of household finances.

10) Install and maintain solar streetlights. Outdoor lighting is important to reduce SGBV and crime. Install solar streetlights to improve lighting in the community, particularly isolated areas or near sanitation facilities. Clarify roles for operation and maintenance of streetlights and engage vendors in their maintenance and repair.

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[136] GPA, Access to Energy for Cooking in Displacement Settings, 2023; EnDev, *The State of Sustainable Household Energy Access in Refugee Settings in Uganda: Survey Findings in Rhino Camp Settlement and Imvepi Settlement, Arua District, West Nile Region*. GIZ, 2019.; IFC, *Energy Access Baseline Study in Uganda's Refugee-Hosting Areas*, 2022.

[137] EnDev, *The State of Sustainable Household Energy Access in Refugee Settings in Uganda: Survey Findings in Rhino Camp Settlement and Imvepi Settlement, Arua District, West Nile Region*. GIZ, 2019.

[138] Price, R., *"Clean" Cooking Energy in Uganda – technologies, impacts, and key barriers and enablers to market acceleration*, Institute of Development Studies, 2017.

[139] Elasu, J., Ntayi, J., Adaramola, M., Buyinza, F., Ngoma, M., and Atukaunda, R., *Gender role differentiation in household fuel transition decision-making: Implications for education and training in Uganda*, Frontiers in Sustainability, 2023. 4:1034589.

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Uganda Learning Evidence Accountability

and Research Network

P. O. Box 12018, Kampala – Uganda

www.ulearn-uganda.org