Energy Appliances for the Rwandan Humanitarian Context: Stakeholder Mapping and Consumer Insights

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VeraSol is a global quality assurance program that strives to make safe, affordable, and durable products the default option in the off-grid solar market. Grounded in rigorous testing and international best practices, VeraSol sets quality standards, promotes high-performing solar technologies, and supports the adoption of harmonized policies. We thus help improve the livelihoods of the most vulnerable people in low-income countries, reduce greenhouse gas emissions, and increase clean energy access for all.

EforA is a global coalition dedicated to advancing high-efficiency appliances to enhance clean-energy access among the world's most impoverished communities. Current EforA Coalition members have programs and initiatives spanning 62 countries and 34 key technologies. The Coalition is co-chaired and jointly funded by UK Aid, via the Transforming Energy Access platform, and the IKEA Foundation. However, the views expressed in this report do not necessarily reflect the UK government's official policies.

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Acronyms and definitions

AC – Alternating current, a type of electrical current used in most household appliances and grid-connected systems

BRD – Development Bank of Rwanda, a public financial institution in Rwanda that provides loans and grants for development projects, including renewable energy and energy-efficient appliances

CAPEX – Capital expenditure, the upfront costs associated with purchasing equipment or infrastructure

CET – Clean Energy Technologies, a private-sector supplier of renewable energy technologies, including solar refrigerators and cookers

CLASP – Collaborative Labelling and Appliance Standards Program, an international organization that promotes energy efficiency standards and labels for appliances

DC – Direct current, a type of electrical current used in solar systems and some appliances

EDCL – Energy Development Corporation Limited, a Rwandan government entity involved in energy development and after-sales services for energy products

EAC – East African Community, a regional intergovernmental organisation comprising six countries in East Africa, including Rwanda, which promotes economic integration and cooperation.

EPD – Energy Private Developers Association, an association of private-sector companies in Rwanda's energy sector, working to promote renewable energy and energy efficiency

EPRR – Environmental protection and resource recovery, a system for managing environmental impacts, including e-waste, in Rwanda

ERE – Exécution–Rénovation–Études, a private-sector supplier of renewable energy technology, offering solar refrigerators, solar home systems, and other energy-efficient appliances

ESF – Environmental sustainability fee, a fee paid by importers to support end-of-life management of products, including e-waste

ESSAP – Energy Sector Strategic Plan, Rwanda's national plan for achieving universal energy access and promoting renewable energy

GIZ – Deutsche Gesellschaft für Internationale Zusammenarbeit, a German development agency that supports global sustainable development projects, including renewable energy initiatives

GGGI – Global Green Growth Institute, an international organisation that supports sustainable development initiatives

IEEE – Institute of Electrical and Electronics Engineers, a global professional organisation that develops standards for electrical and electronic technologies

ISO – International Organization for Standardization, an international body that develops and publishes standards for various industries, including energy efficiency

ISP – Internet service provider, any company that provides internet access to customers, often integrated with solar-powered systems in off-grid areas

KEBS – Kenya Bureau of Standards, the national standards body in Kenya, whose certifications are often recognized in other East African Community countries

LPG – Liquefied petroleum gas, a type of fuel used for cooking and heating, often distributed through PAYG models

MINIICT – Ministry of Information Communication Technology and Innovation (Rwanda), the government ministry responsible for ICT and innovation policies in Rwanda

MININFRA – Ministry of Infrastructure (Rwanda), the government ministry responsible for infrastructure development, including energy and transportation

MoU – Memorandum of understanding

NGO – Non-governmental organization

OPEX – Operational expenditure, the ongoing costs associated with maintaining and operating equipment or infrastructure

PAYG – Pay-as-you-go, a business model where customers pay for energy services in small, incremental amounts, often used for solar home systems and other renewable energy solutions.

PV – Photovoltaic, referring to solar panels that convert sunlight into electricity

PUE – Productive use of energy, referring to the use of energy for income-generating activities, such as refrigeration, sewing, or phone charging, particularly in off-grid or humanitarian settings

RBF – Results-based finance, a financing model where payments are made based on the achievement of specific results or outcomes, often used in energy projects

REMA – Rwanda Environment Management Authority, the government agency responsible for environmental protection and management in Rwanda

RICA – Rwanda Inspectorate, Competition and Consumer Protection Authority, the authority responsible for inspecting and enforcing standards, particularly at customs, to ensure compliance with national regulations.

RSB – Rwanda Standards Board, the national body responsible for developing and enforcing standards in Rwanda, including those for energy-efficient appliances

RRA – Rwanda Revenue Authority, the government agency responsible for tax collection and customs enforcement in Rwanda

RURA – Rwanda Utilities Regulatory Authority, the regulatory body responsible for overseeing utilities, including energy, in Rwanda

SACCO – Savings and Credit Cooperative Organization, a member-based financial cooperative that provides savings and loan services, often used for microfinancing energy products

SHS – Solar home system, a standalone solar power system designed to provide electricity to households, typically including solar panels, batteries, and energy-efficient appliances

SME – Small and medium enterprises

UNEP – United Nations Environment Programme, a UN agency responsible for coordinating environmental activities and promoting sustainable development

UNHCR – United Nations High Commissioner for Refugees, the UN agency responsible for protecting and supporting refugees worldwide

Executive Summary

Electrical appliances play a key role in humanitarian settings. In Rwanda, access to energy is crucial for marginalized peoples living in refugee camps, as it enables them to meet their basic needs, improve their livelihoods, and enhance their overall well-being through clean cooking, lighting, and improved access to education, and economic opportunities. Most households (approximately 90%) in refugee camps in Rwanda are off-grid; this makes them ideal candidates for solar home system (SHS) adoption, provided that affordability can be improved. Outside of the household, refugees in Rwanda engage in a wide range of entrepreneurial activities. These include farming and selling agricultural produce; retailing goods, such as clothing and other commodities; and operating internet cafés, phone-charging stations, and cinemas. Additionally, they are involved in craftsmanship, including woodcraft and tailoring, as well as in providing hospitality services through restaurants and catering. While some businesses are connected to the grid, not all have access to reliable energy sources. These might rely on off-grid solutions, such as SHSs, which provide basic lighting and power for their operations. Additionally, some businesses use alternative energy sources, such as diesel generators, to meet their power needs.

Appliances designed for off-grid use (i.e. energy-efficient DC appliances and solar devices) are important in Rwanda's humanitarian context because they enable access to electricity for refugees. Without grid electricity to rely upon, households (and to a lesser extent, businesses and institutions) must rely instead upon off-grid installations and appliances, i.e. solar irrigation installations and SHS. The quality and durability of the installations and appliances is key to ensuring the proper functioning of these technologies, and thereby the continued access to energy. Without the guidance that product standards offer, importers and consumers alike can struggle to differentiate between high- and low-quality products. As a result they risk choosing products that will not meet their needs or, worse, fail after an unacceptably short time period - i.e. 6-12 months.

This report is published alongside the VeraSol *Procurement Handbook for Energy Appliances*, which provides guidelines for establishing minimum standards while

procuring energy-efficient appliances. The handbook serves as a crucial resource for procurement officers, program implementers, and energy consumers, providing guidance on how to ensure that the appliances they choose are durable and environmentally sustainable, contribute to enhanced energy efficiency, and provide long-term economic viability. This support document details key information organizations must consider when seeking to procure appliances for use in the Rwandan humanitarian setting.

In the following pages, we explore three key considerations for procuring appliances in the Rwandan humanitarian context.

1. **Appliance categorization** by sector (household, business, and community use), highlighting how different users prioritize parameters such as energy efficiency, affordability, and ease of repair
2. **Procurement challenges** unique to refugee contexts, including financing barriers, supply chain constraints, and the tension between short-term affordability and long-term sustainability
3. **Policy and practical considerations** associated with Rwanda's e-waste regulations and the logistical hurdles of distributing and maintaining appliances in camp environments

Understanding these dynamics is critical for stakeholders, from aid agencies to private suppliers, who aim to design or deploy energy-efficient solutions that are both practical and scalable. When appliances are well-suited to users' realities, they can amplify the benefits of energy access, enabling everything from safer cooking and lighting to income-generating activities. Conversely, poorly suited technologies risk becoming costly for users, exacerbating the very vulnerabilities they were meant to address.

The following sections offer insights to inform procurement, program design, and policy in humanitarian energy initiatives.

Key messages and recommendations

Energy access gaps persist.

- SHSs power 70% of electrified refugee households in Rwanda; yet, 36% remain without electricity.
- Grid-connected businesses benefit from round-the-clock access to electricity and from the greater variety of AC appliances available (when compared to the smaller choice of DC appliances on the market) but affordability and reliability challenges endure.
- Households prioritize energy-efficient, durable appliances, while small and medium enterprises (SMEs) need productive-use technologies (e.g., solar mills, refrigerators) to enhance livelihoods.

Procurement must balance affordability and quality.

- Standards matter: Prioritize IEC / RSB-certified appliances to avoid failure of substandard equipment. DC-compatible products are essential for off-grid users.
- Emerging tech potential: Solar-powered tools (e.g., egg incubators, sewing machines) remain underutilized but require training and pilot projects to increase demand.
- E-waste looms: Rwanda's e-waste landscape could be enhanced through the introduction of take-back systems. Partner with recyclers such as EnviroServe to mitigate camp dumping.

Purchasing power is key.

- PAYG dominates: 85% of households rely on pay-as-you-go models. Innovative approaches, including subsidies and refugee-tailored microloans, could expand access.
- Financing barriers: 44% of refugee entrepreneurs lack an income. Grants and gender-inclusive microloans could help increase appliance uptake.

Policy and coordination are critical.

- Fix import bottlenecks: Customs delays (1–4 months) hinder supply. Pre-clearances for certified solar goods could streamline delivery lead times.

- Strengthen e-waste enforcement: Mandate producer recycling schemes and expand camp collection points.

Closing Rwanda's refugee energy gap requires appliances that are affordable, durable, and aligned with user needs—backed by smart financing, policy, and cross-sector collaboration.

Procurement guidance: Rwanda

In December 2024, researchers from CLASP and Practical Action conducted a stakeholder consultation process, interviewing key informants. These participants from 14 organizations— Rwanda Development Bank (BRD), Clean Energy Technologies (CET), Collaborative Labelling and Appliance Standards Program (CLASP), Energy Development Corporation Limited (EDCL), Energy Private Developers Association (EPD), Exécution–Rénovation–Études (ERE), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Ministry of Infrastructure (MININFRA), Rwanda Environment Management Authority (REMA), Rwanda Inspectorate, Competition and Consumer Protection Authority (RICA), Rwanda Standards Board (RSB), Rwanda Revenue Authority (RRA), Rwanda Utilities Regulatory Authority (RURA), and United Nations High Commissioner for Refugees (UNHCR)—were invited to share their experiences and perspectives on providing appliances and renewable energy solutions in refugee settings. The interviews revealed several consistent themes across the stakeholders, highlighting shared sentiments, challenges, and practical advice relevant to the procurement of appliances in Rwanda.

Product standards and certification

A recurring theme across the interviews was the importance of—and difficulty in—adhering to standards and certifications. Standards are important in order for consumers and importers to effectively discern quality in the products available to them, and thereby to have the best chance of procuring the most appropriate, effective and durable products for which their budgets allow. Consumers and importers often do not have a strong

enough grasp of the various standards and certifications, and so will be unsure how to apply them to their purchasing decisions. Furthermore, while RSB and RICA have strong knowledge and understanding of the standards and certifications (including both international examples and those set by RSB), the capacity of these two bodies to test and verify imported products is limited.

The Rwanda Standards Board (RSB) and RICA play a crucial role in setting and enforcing standards: RSB is responsible for developing national standards, while RICA enforces these standards during customs clearing and product inspections. The Ministry of Infrastructure (MININFRA), working in partnership with RSB and RICA, has published guidelines for solar energy kits (SEKs) with a focus on product quality and responsible customer care. The Development Bank of Rwanda (BRD) also emphasizes the importance of certification, requiring domestic Rwandan companies to provide proof of product compliance with international standards before approving loans that they might use to procure products (typically from overseas wholesale suppliers and manufacturers).

Belecom, CET, and Solektra emphasized that their products meet international standards, such as the quality standard for solar energy kits (IEC TS 62257-9-8). Belecom noted that its solar home systems (SHSs) are certified by VeraSol, while CET mentioned that its solar refrigerators and cookers are tested for performance before being offered to customers. Solektra also highlighted that its SHS are VeraSol-certified; it works closely with the Rwanda Inspectorate, the Competition and Consumer Protection Authority (RICA) and the Rwanda Revenue Authority (RRA) to ensure compliance with local regulations.

Guidance for procurement

While interviews suggest that reputable companies operating in Rwanda have a general willingness to comply with national and international quality requirements, procuring entities should not assume that the off- and weak-grid appliances available in the Rwandan market are of acceptable quality. Products without certification may lack durability and could be liable to fail within 6-12 months of purchase, rather than the 5-10 years more typically expected from higher quality appliances.

To mitigate the risk of procuring sub-standard products, procurement personnel should refer to the accompanying *Procurement Handbook* for relevant standards and additional guidance and take the following actions:

- Ensure that appliances meet international standards, such as IEC TS 62257-9-8.
- Request test certificates from manufacturers to confirm energy efficiency and performance.
- Work closely with RSB and RICA to verify compliance with local regulations.

Import processes and challenges

Another common topic, which was often mentioned by the private-sector actors interviewed, was the imports process for electrical appliances. Import duty exemptions can be challenging to obtain, for example.

Solektra highlighted the complexities of needing to prove that imported appliances are solar-compatible to benefit from tax exemptions—specifically for "Specialized solar powered equipment and accessories including deep cycle batteries which exclusively use and/or store solar power", as stated in RRA's Exemptions Regime. Solar installations produce DC electricity, and so (expensive) inverters must be employed before AC appliances may be utilized. To avoid this expense, DC appliances may be preferred for solar applications. However, as DC appliances are also useful in grid-connected scenarios, the importer must go to extra lengths to reassure RRA that these DC appliances are indeed intended for solar applications and not for on-grid applications. Evidence of a paid invoice for solar PV equipment is an example of evidence accepted by RRA in this capacity.

Power Africa, a former USAID program, noted that customs officers often lack the technical knowledge and/or capacity to test and assess imported products, which can lead to delays in the order of 1–4 months. Belecom and ERE mentioned that sourcing products from overseas, particularly from China, involves long lead times and advance payments, which can strain cash flow. ERE also pointed out that logistical challenges, such as the time required for shipping and customs clearance, can impact its ability to meet demand.

Guidance for procurement

- Engage with the RRA early in the procurement process to ensure compliance with tax exemption requirements for solar-compatible appliances.
- Factor in long lead times and advance payments when planning procurement from suppliers, who are invariably overseas because Rwanda does not have domestic manufacturers of solar PV technology or most appliances used in this context.
- Provide detailed documentation to customs officers to avoid delays, including proof of solar compatibility and energy efficiency certifications. In particular, RRA can typically only approve DC appliances for tax exemption and requests further indication that the appliances will be used specifically with a solar source (and not connect to the national AC electricity grid serving Rwanda). For example, importers may be asked to present invoices for the solar PV panels used as evidence that the appliances will run on solar power.

Common challenges faced by the private sector and users

The greatest challenge is affordabiity - user costs are holding back the the adoption of SHSs in refugee camps.

Product cost

Several interviewees, including Belecom, CET, and MeshPower, identified common challenges in delivering energy-efficient solutions to refugee camps. Belecom highlighted the low purchasing power of refugees, which limits its ability to afford high-quality appliances. CET noted that, while there is a growing demand for solar refrigerators and cookers, their high cost is a barrier to their adoption.

Pay-as-you-go (PAYG) models

MESH Power discussed the challenges in implementing PAYG models, which require significant upfront capital and have long repayment periods. It also mentioned that government permissions and approvals can be a major bottleneck, particularly for projects involving mini-grids.

Consumer awareness

On the user side, Belecom and Solektra reported that customers often lack awareness of how solar systems work, leading to unrealistic expectations about energy availability—customers may find that their system provides only 6–8 hours of power per day, due to the sizing of the panel(s) and the battery. A system that provides power for a longer period of time would require larger panel(s) and/or a larger battery; this would imply higher costs as well (system costs tend to increase with increases in system capacity). This highlights the need for company-led awareness campaigns to educate customers on new technologies. Solektra also noted that customers can, understandably, be biased towards technologies they are familiar with—for example, they may have a preference for diesel grain milling over electric milling. This can influence appliance choices.

E-waste management

Several organizations acknowledged the need for better e-waste practices.

Belecom and Solektra have established partnerships with EnviroServe for the collection and recycling of end-of-life products. Belecom mentioned that most components of its SHS products are repairable, and only fire can render them unusable. Solektra has implemented a program where customers can return used products for recycling; it is also working on raising awareness about e-waste management.

RSB and RICA are similarly involved in e-waste management, with RSB developing standards and RICA enforcing regulations. However, CET and ERE admitted that they currently lack a comprehensive e-waste management plan, indicating a gap that needs to be addressed.

Guidance for procurement

- Consider the purchasing power of consumers and explore subsidies or financing options to make appliances more affordable. PAYG delivery models can significantly increase affordability, but suppliers must bear the initial capital expenditure burden. Another alternative option is to facilitate financing through microfinance lenders.

- Ensure that customers are educated about the capabilities and limitations of SHSs to manage expectations.
- Be aware of familiarity bias and tailor appliance offerings to meet local needs.
- Partner with organizations such as EnviroServe to establish e-waste collection and recycling programs.
- Extend the lifespan of appliances by ensuring that they are designed for repairability.
- Include e-waste management plans in procurement contracts to ensure that end-of-life products are disposed of responsibly.
- Reduce e-waste by setting minimum quality requirements, as described in the accompanying Procurement Handbook, that ensure durable products.

The role of the government

The role of the government in promoting the uptake of off-grid and weak-grid appliances emerged as a key theme in the discussion.

The Energy Private Developers Association (EPD) and BRD highlighted the importance of government policies and subsidies in driving the adoption of energy-efficient appliances. The EPD works with the Ministry of Infrastructure (MININFRA) to develop guidelines for productive use of energy (PUE) appliances, while BRD provides loans and grants to companies offering SHS and clean cooking technologies.

RSB and RICA emphasized the need for government support in setting and enforcing standards, particularly for new and innovative technologies such as solar PV cooking. Power Africa also noted that government incentives, such as tax exemptions for renewable energy equipment, are crucial for encouraging private-sector investment.

Guidance for procurement

- Leverage government subsidies and tax exemptions to reduce the cost of energy-efficient appliances.
- Stay informed about government guidelines and standards for PUE appliances.

- Engage with government bodies, such as EPD and BRD, to access financing and support for procurement.

The role of NGOs

NGOs play a significant role in supporting energy access in refugee settings. NGOs aim to increase energy access and generally work to support the private sector actors engaged in the supply of energy technologies, as well as the consumers of these technologies. The challenges involved with this approach are a low awareness of the technologies among suppliers and customers alike.

Save the Children shared its experience setting up a solar-powered internet café in a refugee camp, highlighting the importance of partnerships with local businesses and the need for after-sales support. It also emphasized the value of having a procurement guide for energy-efficient appliances; this would help NGOs and other stakeholders make informed decisions.

GIZ discussed the challenges associated with sustainability interventions in humanitarian contexts, particularly the need for long-term customer care after the initial distribution of any energy system or appliance. It also highlighted the importance of aligning projects with the needs of both refugees and host communities to avoid market distortions.

Guidance for procurement

- Partner with NGOs to access expertise and funding for energy-efficient projects.
- Ensure that procurement contracts include provisions for after-sales support and customer care.
- Refer to the accompanying *Procurement Handbook* to make informed decisions about technical requirements for appliances and for suppliers.

Preliminary consumer mapping: Household appliances

The broader context: Households and appliances in refugee camps

To support this guidebook with consumer insights, we asked 144 households in Kiziba and Nyabiheke refugee camps about their use of electrical appliances.

Household occupancy

Household sizes in the surveyed Rwandan refugee camps varied significantly, ranging from 1 to 14 individuals. The most common household size was 5–7 residents, reported by 44 households. Smaller households of one to three individuals were also common, while larger households of nine or more residents were less common but still present. This variability reflects diverse family structures and living arrangements, which may have implications for resource allocation and service planning in the camps. Notably, improving one household's electricity access will most typically impact five to seven individuals.

Access to electricity among households

Of the 144 households surveyed, a majority—92 respondents—reported having access to electricity. Among those with access, most households (approximately 70%) indicated that electricity was available for 6–12 hours per day, while a smaller portion reported access for more than 12 hours or less than 6 hours. SHSs were the primary source of electricity, serving as the energy source for nearly all connected households—except for 10 households that were connected to the national grid. This highlights the dominant role of off-grid energy technologies in providing electricity to refugee households.

However, 52 households (36%) reported having no access to electricity, underscoring a significant gap in energy access. For those with access, reliance on SHSs suggests the successful deployment of renewable energy solutions, though the variability in daily access hours indicates potential challenges in system reliability or capacity. Of the 92 respondents with access to electricity, 89% used solar technology.

REG (Rwanda Energy Group) offers new connections to their electricity grid at a cost of 56,000 RWF (38.97 USD), provided that the customer is within 37 meters of existing infrastructure. New customers who are further away must pay an additional cost for extension.

Prior to our survey, Practical Action collected separate, relevant data in a 2022 survey during the second phase of the Renewable Energy for Refugees program (RE4R II). It surveyed a random sample of 1,082 households across five camps—Mahama, Kiziba, Kigeme, Nyabiheke and Mugombwa; 18% of these households were situated in the host communities adjacent to the camps. In our more extensive 2022 survey, 69% of respondents reported having access to “modern” forms of electricity, including the grid (10%), SHSs (36%), solar lanterns (16%), and rechargeable batteries (6%). The remaining 31% reported either having no access to electricity or that they were using non-rechargeable batteries and other such systems for lighting, radio, and other services. On average, households could access six hours of electricity per day; only 24% had access to power for more hours per day.

Respondents from the Kigeme and Nyabiheke camps reported having greater access to “modern” forms of electricity than those from other camps (83% and 88% respectively). Of these, SHSs represents the most widely used primary energy system for power generation, with 76% of respondents in the Kigeme camp and 74% in the Nyabiheke camp having access to an SHS. In Kigeme and Nyabiheke, respondents reported being able to access seven hours and five hours of electricity per day on average, respectively.

In other camps, access to “modern” forms of electricity is limited; it is lowest in Kiziba and Mugombwa, with only 58–59% of respondents reporting access to SHSs (36% in Kiziba; 21% in Mugombwa), solar lanterns (11% in Kiziba; 21% in Mugombwa), or rechargeable batteries (11% in Kiziba; 15% in Mugombwa). In Kiziba, Mahama, and Mugombwa, respondents reported receiving an average of four hours of electricity per day. Virtually no respondents from any of the camp settings reported having access to electricity from the main grid.

Finally, the 2022 survey results revealed that 58% of the 1,082 respondents reported that their primary energy system did not allow them to charge their mobile phones.

When comparing the older 2022 survey results with the 2024 survey results, we observe that both access to electricity and the uptake of solar power has shown a marked increase (Figure 1).

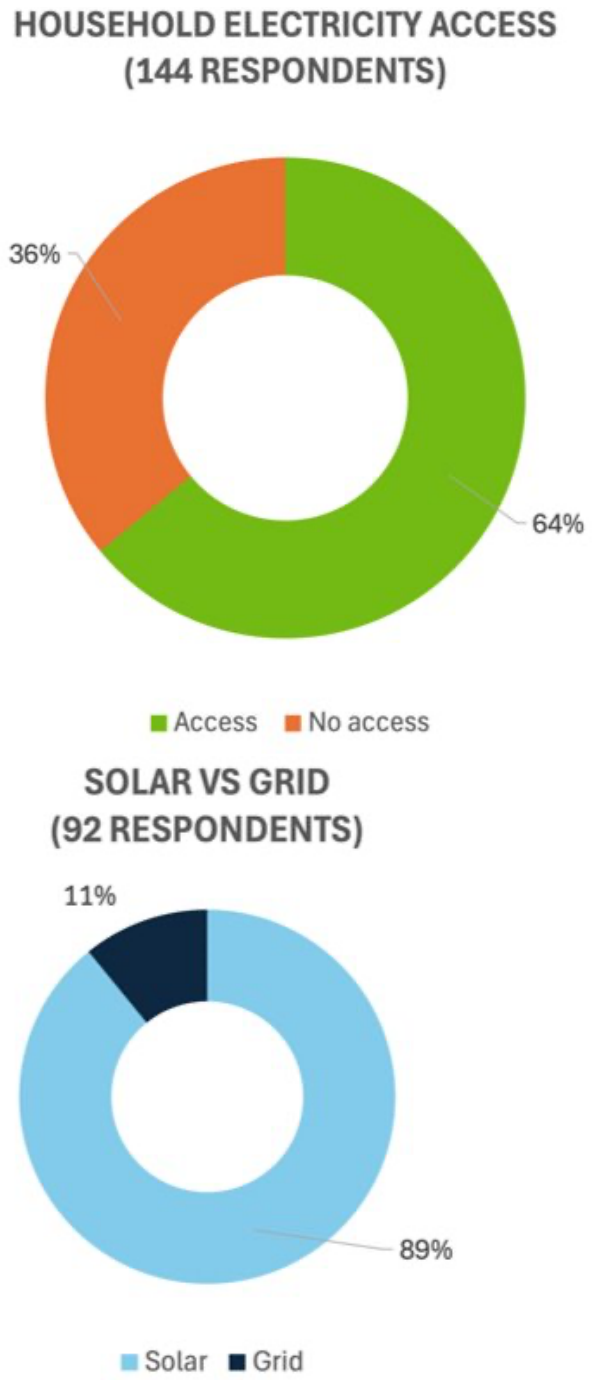

Figure 1: Increase in electricity access and solar power use
Source: Authors' analysis

Appliance ownership/prevalence

The 144 households were asked about the appliances they own and use. The prevalence of various electrical appliances is shown in Figure 2.

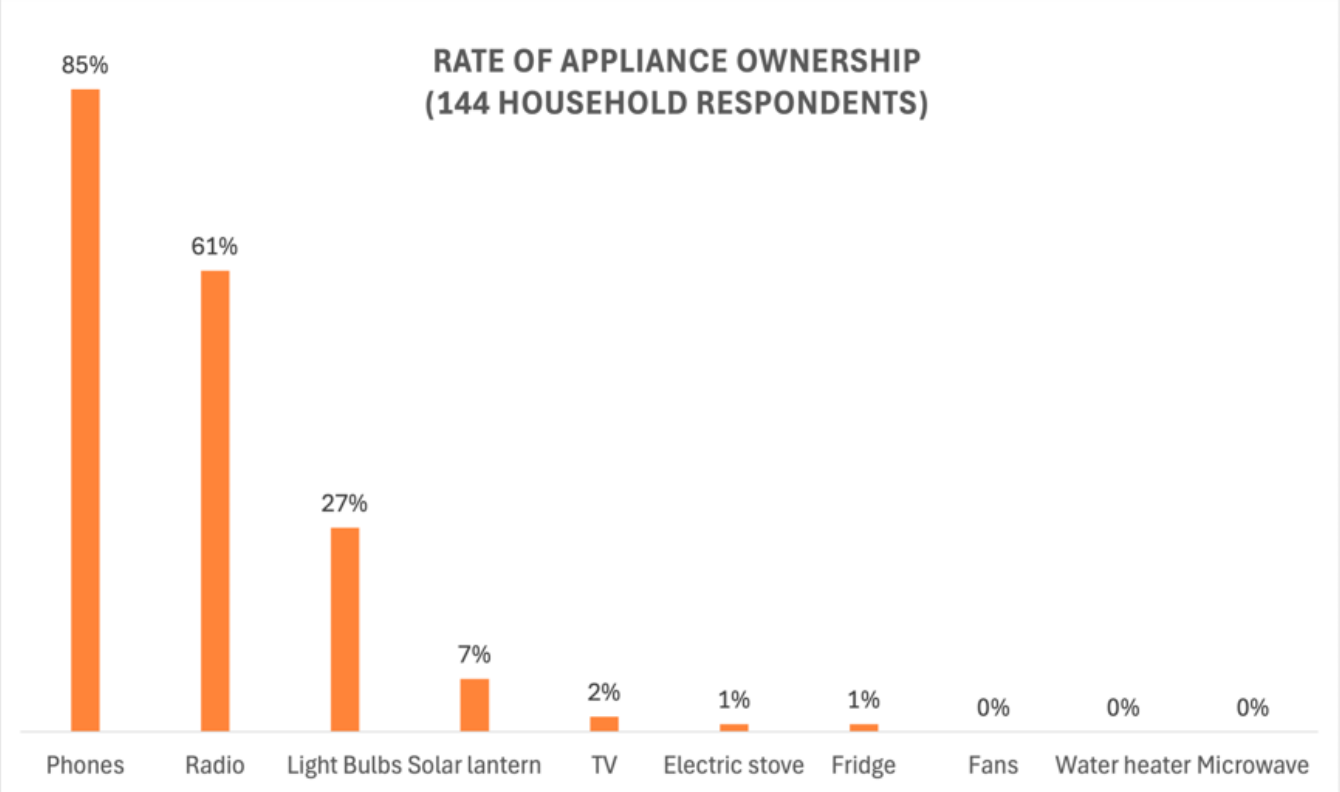

Figure 2: Rate of appliance ownership across 144 households
Source: Authors' analysis

Practical Action's 2022 survey[1] asked 1,082 respondents about which energy services would most benefit them. Respondents across all settings mentioned phone charging (70% of mentions) and lighting (60% of mentions) as priorities, followed by information and communication services, such as radios (57%) and TVs (37%). Priorities do not vary significantly across camps. It is important to note that the mere mention of these services does not mean a lack of access to them, as the question can be interpreted in different ways. Host communities (the villages, towns and/or settlements located closest to the camps but distinctly outside the bounds of the camp itself) can tend to be slightly more focused on higher-tier needs (food processing, computing, etc.), and this is especially true for the host communities adjacent to Kigeme camp and Mahama camp. This is perhaps because the greater economic opportunities found in host communities can result in greater purchasing power, and therefore improved access to energy and

[1] REAR II program survery - Practical Action (2022)

appliances, when compared to refugees. However, host communities in Kiziba, Mugombwa, and Nyabiheke tend to have needs comparable to those in refugee camps.

Purchasing appliances

As a majority of the responses indicate, the households surveyed in Kiziba and Nyabiheke camps primarily procure energy-efficient appliances through PAYG or instalment plans. A smaller number of households reported purchasing appliances with cash, while only one mentioned acquiring them through donations or community programs. This suggests a preference for flexible payment models—such as PAYG—owing to their affordability and accessibility for low-income households, highlighting their importance in enabling access to energy-efficient appliances in resource-constrained settings.

Purchase method	Responses	Percentage (of 126 responses)
PAYG **or** installments	107	85%
Cash	19	15%
No response	18	n/a

Table 1: Preferred payment models in Kiziba and Nyabiheke
Source: Authors' analysis

In the 2022 RE4R II survey[1] of the Mahama, Kiziba, Kigeme, Nyabiheke, and Mugombwa camps and their host communities, 39% of the 1,082 heads of households claimed to have no income due to unemployment (31%), retirement (3%), or disability (5%). In the camps specifically, 44% of heads of households have no source of income, whereas in host communities, the proportion is 14%. A lack of income can result in an unmet need for appliances, given that a degree of purchasing power is typically required in order to purchase appliances.

Perceived importance of appliance attributes

Figure 3 illustrates the responses of the 144 households when asked about the attributes they consider most important when purchasing electrical appliances.

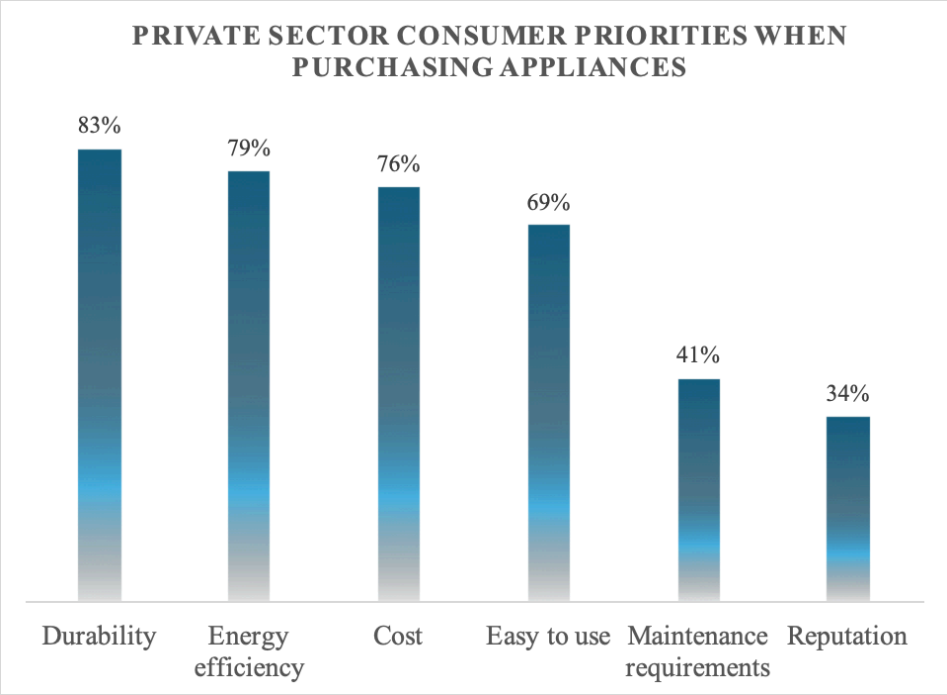

Figure 3: Private-sector consumer priorities when purchasing appliances
Source: Authors' analysis

When purchasing or using appliances, households in Kiziba and Nyabiheke refugee camps prioritize energy efficiency, ease of use, and durability. This reflects a desire for appliances that are cost-effective, user-friendly, and long-lasting. Price and operating costs were also significant considerations, highlighting the significance of affordability and low running costs for households. While some respondents mentioned brand reputation and maintenance requirements, these were less often cited. A small number indicated no specific preferences. It should be noted that the term "energy efficiency" may not be universally understood by respondents and can often be interpreted as referring to the effectiveness of the appliance.

E-waste disposal

Households in the Kiziba and Nyabiheke refugee camps primarily managed old or broken appliances by returning them to the seller, as indicated by Table 2. Storing appliances at home was the second most common method, indicating that respondents did not want to dispose of the items entirely but were also, perhaps, unsure about the best way to proceed. A smaller number of households reported using e-waste collection points or

recycling, while others admitted to throwing appliances away—raising concerns about environmental impact. These findings highlight the need for improved e-waste management systems, including accessible collection points and awareness campaigns to promote sustainable disposal practices in refugee camp settings.

Disposal method	Responses	Percentage
Returning to the seller	61	44%
Storing at home	48	35%
Throwing away	19	14%
E-waste collection point	7	5%
Recycling	3	2%

Table 2: Waste management in Kiziba and Nyabiheke
Source: Authors' analysis

Household opinion on the availability and quality of appliances

Households in the Kiziba and Nyabiheke refugee camps expressed mixed feelings about the availability and quality of appliances, with many stating that current access is insufficient given the population size. While some respondents reported satisfaction, a significant number highlighted the need for more energy-efficient appliances, improved quality, and batteries with larger storage capacities, particularly for powering devices such as bulbs and TVs.

Affordability was a major concern, and many respondents expressed a wish for suppliers to reduce prices and provide free or subsidized electricity, as many refugees struggle with monthly payments (i.e., PAYG or installment plans). Suggestions for improvement included increasing the number of bulbs, enhancing battery efficiency, and introducing alternative energy sources. Respondents also emphasized the importance of expanding access to appliances to support more households and businesses.

Listed in Table 3 are appliances appropriate for use in a typical refugee household. All are DC appliances, connected to an SHS and not the grid.

Appliance	Typical power rating	Power source	Recommended size/specification	Current rate of ownership in refugee camps	Example
Mobile phone	5–10W (charger)	DC	n/a	High	n/a
Radio	~5W	DC	n/a	High	Solar Run Portable Radio
LED bulbs	3W	DC	250 lumens	Medium	Solar Run 3W 270lm
Solar lantern (stand-alone)	3W	DC	50 lumens	Low	Sun King Pico Plus lantern
TV	15–30W	DC	16” diagonal screen	Very low	Startech ST-0019
Electric stove	1,000W	DC	Two burners	Near zero	ECook induction stove
Refrigerator	275 W	DC	65 litres	Near zero	SureChill 1DS65X

Table 3: Appliances appropriate for use in refugee households
Source: Authors’ analysis

SME appliances

The appliance needs of SMEs differ in type, size and number when compared to households. While both settings require lighting solutions, household consumers typically demand cooking appliances while this only applies to SMEs whose business operations are focused on food and beverages. SMEs typically require additional appliances that are specific for their particular type of business – i.e. hair clippers / shaving machines for salons, phone charging power supplies for phone charging operators, refrigerators for kiosks selling soda, milk and cheese. While these clear distinctions exist, the demand for radio and TV appliances is seen in both households and SMEs. In Mahama camp as an example, capital equipment for SMEs can be purchased with financial support from donors including GIZ, World Vision and Mastercard Foundation, though demand for these SME loan schemes is greater than the donor programmes can accommodate. Aside from infrastructural issues, access to finance for women SME operators is also impeded by social/cultural/gendered barriers.

The Broader Context: Businesses and Appliances in Refugee Camps

To support this guidebook with their insights, we asked 29 business operators in Kiziba refugee camp about their use of electrical appliances.

Access to electricity among business operators

Most business operators in Kiziba refugee camps reported having access to electricity, with 27 out of 29 respondents confirming access either through the grid or an off-grid solution. Among those with access, most indicated that electricity was available for more than 12 hours per day, though two respondents reported access limited to 6–12 hours. For 25 respondents, the primary source of electricity was the national grid. Only two operators relied on SHSs for their electricity needs. This suggests that the national grid is the dominant source of power for businesses in these settings, while solar energy remains a supplementary option for a small minority.

The high level of electricity access, particularly for extended periods, could support the growth of businesses. However, the reliance on the national grid highlights the importance of maintaining and expanding grid infrastructure to ensure a consistent and reliable power supply. The limited use of SHSs indicates potential for further adoption of renewable energy solutions, particularly in areas where grid access is constrained.

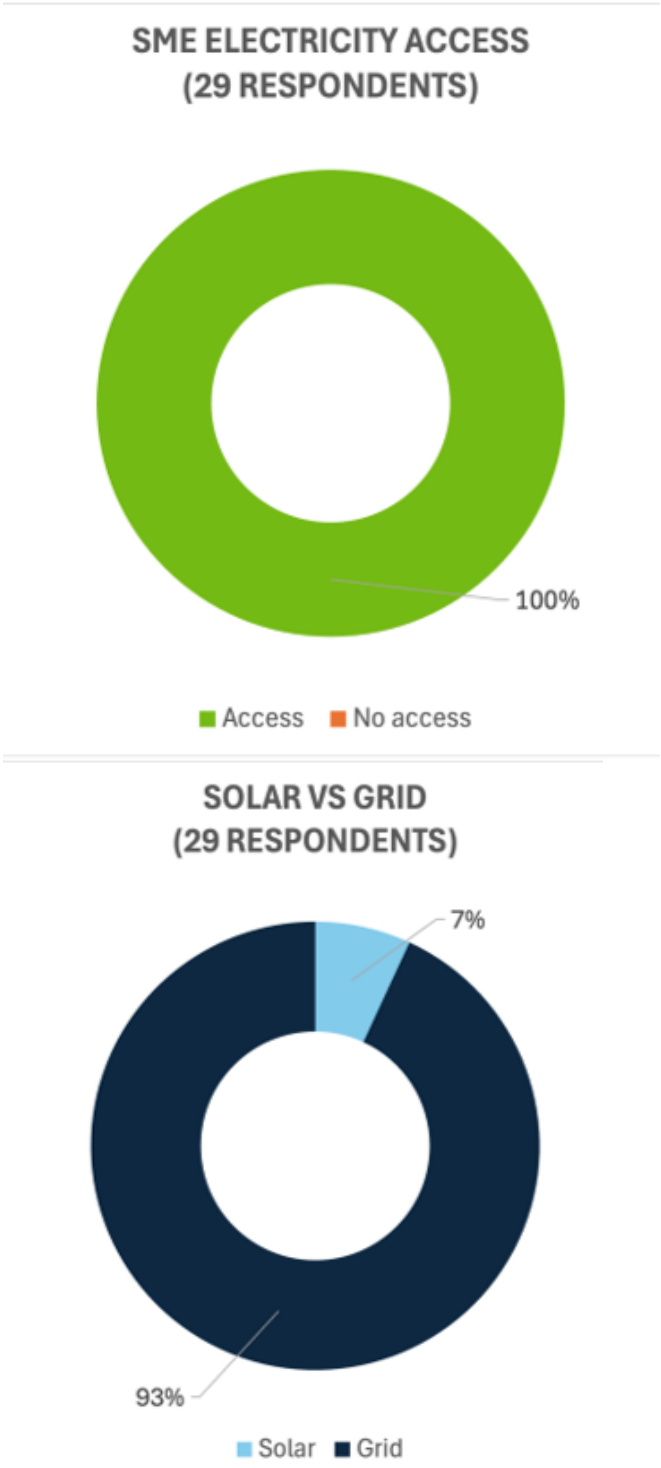

Figure 4: Electricity access among business owners
Source: Authors' analysis

Appliance ownership/prevalence among businesses

We asked the 29 business operators what appliances they own and use in their businesses. Table 6 shows the prevalence of various electrical appliances.

Appliance	No. of respondents owning appliance
Refrigerator/freezer	8
Hair clipper	6
Hair dryer	5
No appliances owned	5
Laptop/PC	3
Phone charger	2
TV receiver	1
Sound system	1
Blender	1
Projector	0
Fan	0
Electric mill	0
Popcorn machine	0
Egg incubator	0
Wood-working machine	0

Table 6: Prevalence of appliances across businesses
Source: Authors' analysis

Data from the 2022 survey indicates productive uses of energy by enterprises. A total of 399 were surveyed: 40 businesses in Kigeme camp, 92 in Kiziba camp, 91 in Mahama camp, 38 in Mugombwa camp, 56 in Nyabiheke camp, and 82 from the host communities adjacent to these camps. Most respondents (89%) mentioned regularly using lighting in the context of their business; 39% mentioned using ICT and entertainment; 15% mentioned heating, including heating for cooking; 8% mentioned motive power; and 5% mentioned cooling. Only 7% of the businesses surveyed reported using no energy applications as part of their business operations.

Purchasing appliances

When asked how they purchase appliances, the business operators reported an overwhelming use of grant support; otherwise, they used cash or PAYG purchasing. This contrasts with household respondents, who largely relied on timed payments for purchasing appliances (either PAYG or purchase installments).

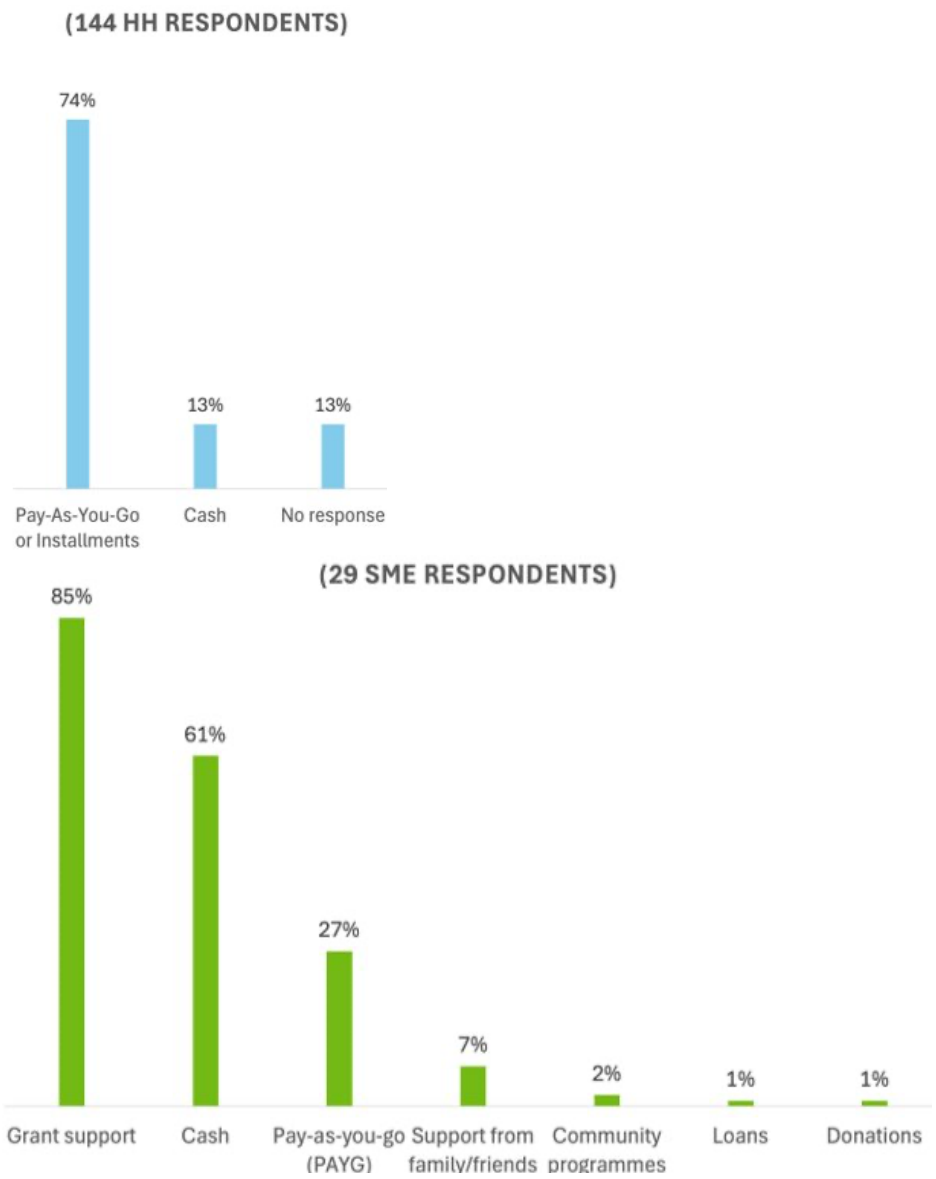

Figure 5: Payment methods in appliance purchasing for business
Source: Authors' analysis

Appliance quality and maintenance

A significant portion of business operators in Kiziba refugee camps (13 out of 29) reported issues with their appliances. Common issues included overheating (such as of machines and hair dryers) and functional failures (e.g., flat irons not switching on or gel machines providing insufficient heat). Electrical damage and lack of long-term durability were also frequently cited, with one respondent noting that their appliance was damaged by lightning during a thunderstorm. Additionally, some operators highlighted limitations in appliance capacity, such as refrigerators with small internal volumes and insufficient tools

for repairs. Specific examples included damaged printers at an internet café and as well as switching system malfunctions. These findings underscore the need for more durable, high-quality appliances and improved access to repair services to address recurring technical and operational challenges.

A significant portion of respondents mentioned that when appliances break down, most business operators in Kiziba refugee camps rely on local technicians for repairs and maintenance. However, a notable number reported having no access to repair services, highlighting the need for increased maintenance support, while a few mentioned that they seek support from suppliers or manufacturers. Their reliance on local technicians highlights the need to develop local capacity for appliance repair, while the limited options available to many businesses underscore a critical need to enhance access to maintenance services in these settings. From the customer's perspective, the availability of technicians is a function of the capacity of local technicians and the supplier's willingness to pay technicians to provide after-sales service. This, in turn, will depend on the business delivery model and whether sales margins are sufficient to accommodate these costs.

Perceived importance of appliance attributes

When asked which attributes are most important when considering the purchase of electrical appliances, 29 business owners responded as follows (see Figure 6).

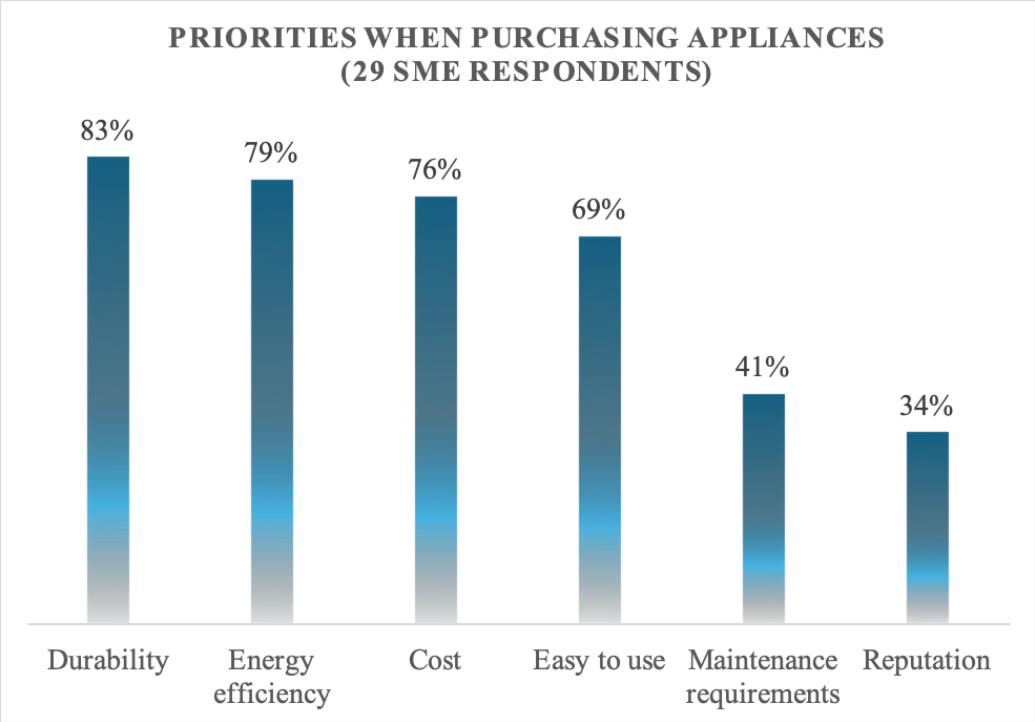

Figure 6: Priorities when purchasing appliances for business
Source: Authors' analysis

In this context, "energy efficiency" is not necessarily understood in the conventional sense; rather, as with households, it is interpreted as "high performance" or "effective", which is a key consideration for durability.

Gaps in appliance supply

Business operators in Kiziba refugee camps requested a variety of appliances to enhance their businesses. Commonly requested items included refrigerators, televisions, blenders, and sewing machines, reflecting a demand for both food-related and service-oriented tools. Specific requests also included specialized equipment, such as sugarcane juice extractors, coffee espresso machines, and meat grinders, highlighting diverse aspirations for growth. Additionally, they frequently mentioned electronic tools like laptops, printers, and chargers, indicating a desire for improved operational efficiency and connectivity. These responses underscore the need for tailored appliance support to meet the varied and specific needs of businesses in refugee camp settings.

Business operators in the Kiziba refugee camps highlight the need to improve the quality and durability of appliances. Many participants expressed a desire for upgrades to ensure longer-lasting performance, reduced electricity consumption, and fewer operational issues, such as sudden breakdowns. Specific suggestions included larger refrigerators with higher capacity, and enhanced camera lenses (as we were told by one photographer, who finds business in producing photographs for formal occasions and official documentation, such as visas and other applications). Overall, the feedback underscores a clear demand for appliances that are not only effective but also more reliable.

E-waste and disposal

All business operators in the survey sample responded “important” or “very important” when asked about the importance of a plan for responsible e-waste management at the end of an appliance’s lifecycle. There are limited opportunities and incentives for Rwandan businesses to adopt responsible e-waste disposal practices. Currently, aside from a recommendation that suppliers maintain a partnership with a recycling and disposal partner (such as EnviroServe), there is no effective, mandatory policy in place for the disposal of electrical appliances in Rwanda. There is thus a need for policies and practices that safeguard the country’s environment while also generating valuable input for downstream manufacturing processes. For example, SLS Energy, a Rwandan startup specializing in battery recycling, combines usable cells into newly assembled battery packs for stationary applications.

Opinions on appliance quality and availability

The 29 business operators across the three refugee camps report benefiting from the availability and quality of certain appliances, particularly those supported by grants, such as refrigerators, which enhance business operations (including milk refrigeration) and thereby improve the customer experience. Participants expressed enthusiasm for the potential of energy-efficient appliances to improve productivity, create job opportunities (i.e. through the potential to supply commercial services such as phone charging, hairdressing etc), and enable business expansion through innovation. Many emphasized the critical role of electricity in driving development and improving livelihoods, with several

suggesting that increased access to electronic devices, either through full or partial support, would significantly boost their businesses and community development.

Business operators also highlighted the importance of durable, high-quality materials provided at low costs or through grants, which would allow them to offer multiple services and enhance their competitiveness. Overall, the feedback underscores a high level of interest in energy-efficient appliances and a clear recognition of their transformative potential for both individual businesses and the broader community.

Emerging technologies

In Kiziba refugee camps, consultations with business operators and research organizations highlight a promising opportunity to introduce emerging technologies. There is significant demand and anticipated uptake for:

- Solar refrigerators
- Solar egg incubators
- Solar mills
- Solar sewing machines
- Welding machines
- Carpentry equipment
- Solar water pumping/irrigation
- Milk coolers

Support for increasing the uptake of appliances

Adoption of appliances by households and SMEs in refugee camps can be increased by improving the affordability of appliances. This can be achieved by lowering the price of appliances (perhaps through improvements to the supply chain) and providing government subsidies and affordable financing options. Individuals in camps face difficulties accessing microfinance loans; these are also available to refugee groups to only a limited degree. Innovations in microfinance, particularly in terms of reducing costs

and risks for microfinance lenders, may help households and SMEs gain greater access to the capital required to purchase appliances.

Data collected during the 2022 survey are informative with regard to access to finance: 30% of respondents across all settings reported never having accessed any source of finance; 50% of respondents reported having accessed informal loans from family and friends—this is by far the most widespread form of finance, followed by savings groups (44%), money lenders (37%), microcredit (13%), and banks (6%). (Percentages overlap because respondents may have used more than one source at any point in time.) If we consider only the camps, we notice a slightly higher reliance on money lenders (39%) and a lower reliance on savings groups (40%), microcredit (11%), and banks (3%). The opposite trend can be observed for host communities, where savings groups, microcredit, and bank loans emerge as the most frequently used sources of finance (61%, 22%, and 20% respectively); host communities rely less on money lenders (30%).

Salon/barber basket

The list in Table 4 shows the appliances currently employed at a typical salon, along with one additional appliance for which there could be demand. Businesses in Kiziba refugee camps are typically connected to the grid; they use both AC and DC appliances. DC appliances would need to be connected to a specific but inexpensive AC–DC power supply (much like a phone charger power supply) or to a solar system supplying DC.

Appliance	Typical power rating	Power source	Recommended size/spec	Current adoption in refugee camp salons	Example model
Shaving machine	3-10W	AC or DC	n/a	High	Winningstar ST 5600 (DC example)
Hair dryer	1500W	AC	n/a	High	Many AC dryers available
Radio	~5W	DC	n/a	Low	Solar Run Portable Radio
LED bulbs	3W	DC	250 lumens	High	Solar Run 3W 270lm
TV	15-30W	DC	16” diagonal screen	Near zero	Startech ST-0019

Table 4: Appliances used at salons in Kiziba refugee camps

Source: Authors’ analysis

Bar/dairy/restaurant basket:

Table 5 shows the appliances that are currently employed at a bar, dairy, or restaurant, and one additional appliance for which there is an indication of potential demand (the blender). Businesses in Kiziba refugee camps are typically connected to the grid, and so they may employ the use of both AC and DC appliances. DC appliances would need to be connected to a specific but inexpensive AC–DC power supply (much like a phone charger power supply) or to a solar system supplying DC.

Women in business

In this specific bar/dairy/restaurant sub-sector, the business operators are most often women. There are specific contexts and challenges relevant to women operating businesses in Rwanda, specifically in relation to access to finance for the purchase of appliances. When designing programs, it is important to consider these barriers and to make a conscious effort to overcome them Specific schemes exist to enable access to finance for women in business, including an A-light scheme to finance the purchase of assets to enable SME ownership and operation for young mothers in Mahama camp, for example.

Appliance	Typical power rating	Power source	Recommended size/spec	Current adoption in refugee camp businesses	Example model
LED bulbs	3–8W	DC or AC	250 lumens	High	Solar Run 3W 270lm
Refrigerator	20–30W	AC	100+ litres	Medium	Felicity Solar FL-SDG-118L
Blender	400W	AC	n/a	Near zero	Geepas GSB44027

Table 5: Appliances used at bars/dairies/restaurants
Source: Authors' analysis

Ministerial guidelines

The Government of Rwanda has established clear guidelines to ensure the quality, safety, and sustainability of solar home systems (SHS) and associated appliances. All imported products must comply with international standards (e.g., IEC certifications) and undergo verification by the Rwanda Standards Board (RSB). Key requirements include minimum efficiency ratings for solar panels (15%), durable batteries (5+ year lifespan), and safety features such as overcharge protection. Additionally, products must be labeled with technical specifications and accompanied by user manuals in local languages. Importers are encouraged to provide after-sales support, including spare parts and repair services, to prolong product usability, particularly in off-grid humanitarian settings.

Rwanda's e-waste regulations mandate responsible disposal practices, prohibiting the import of substandard or used electronics. Importers must adhere to extended producer responsibility

(EPR) schemes, ensuring end-of-life recycling through partnerships with licensed handlers like EnviroServe. Products must also avoid hazardous materials and include clear disposal instructions. In refugee camps, stakeholders should collaborate to establish e-waste collection points and awareness campaigns. Non-compliance risks fines or import bans, underscoring the need for certified, durable appliances aligned with national sustainability goals.

A more extensive description of the guidelines is available as an appendix to this report.

APPENDIX 1: Ministerial guidelines

The Government of Rwanda has published several guidelines relevant to the procurement of electrical products and appliances in Rwanda.

Ministerial guidelines on minimum requirements for SHSs[23]

This section outlines the minimum requirements and guidelines for SHSs in Rwanda, focusing on quality, safety, and performance standards. For importers of electrical equipment, particularly SHSs and the associated DC appliances, the following points are most relevant.

1. **Product quality and certification**
    a. All SHSs and associated appliances must meet international quality standards (e.g., International Electrotechnical Commission [IEC] standards) and be certified by recognized testing and certification bodies.

    b. Products should be tested for durability, efficiency, and safety to ensure that they can withstand local environmental conditions.

2. **Technical specifications**
    a. Solar panels must have a minimum efficiency of 15% and a warranty of at least 10 years.

    b. Batteries should be durable, with a minimum lifespan of five years, and should comply with safety standards to prevent leakage or explosion.

    c. Charge controllers must have overcharge and deep discharge protection to extend battery life.

[2] Ministerial Guidelines on Minimum Standards Requirements for Solar Home Systems – MININFRA 2018
https://www.reg.rw/fileadmin/user_upload/MINSITERIAL_GUIDELINES_On_Minimum_Standards_Requirements_for_Solar_Home_Systems-August_2018.pdf

[3] A note on terminology used throughout the guidelines:
- "must" indicates a mandatory requirement, without which the product may be rejected by RICA
- "should" indicates a non-mandatory recommendation

d. DC appliances should be energy-efficient and compatible with SHS voltage and power output.

3. **Labeling and documentation**
    a. Products must be clearly labeled with technical specifications, including wattage, voltage, and efficiency ratings.

    b. User manuals in English, French, or Kinyarwanda must be provided, covering installation, operation, and maintenance.

4. **Environmental and safety considerations**
    a. Products should be designed to minimize environmental impact and should account for the proper disposal or recycling of batteries and electronic components.

    b. Safety features such as short-circuit protection and fire resistance are mandatory.

5. **After-sales support**: Importers are encouraged to provide comprehensive after-sales services, including spare parts and technical support, to ensure the long-term usability of the product.

6. **Compliance and verification**
    a. Imported products must undergo verification by the RSB to ensure compliance with national regulations.

    b. Non-compliant products must be rejected or removed from the market.

These guidelines ensure that imported SHSs and appliances are reliable, safe, and suitable for use in Rwanda, particularly in challenging settings such as refugee camps. Importers should prioritize quality and compliance to avoid regulatory issues and ensure the sustainability of their products.

Ministerial guidelines on e-waste management

The National E-Waste Management Policy for Rwanda 2018 outlines regulations and guidelines for the import, use, and disposal of electrical and electronic equipment, including SHSs and DC appliances. For an importer bringing these products into Rwanda, particularly in refugee settings, the following requirements are critical:

1. Product compliance and restrictions

a. **Banned imports**: Rwanda prohibits the import of used or substandard electronic and electrical equipment unless certified for refurbishment.

b. **Extended producer responsibility**: Importers must ensure proper end-of-life disposal or recycling of products, either through take-back schemes or partnerships with licensed e-waste handlers.

c. **Energy efficiency and toxicity standards**: Imported appliances (including solar systems) must meet Rwandan safety and efficiency standards, avoiding hazardous materials such as lead, mercury, and cadmium.

2. Labeling and documentation

a. **Clear disposal instructions**: Products must include labels (in English, French, or Kinyarwanda) that inform users how to safely dispose of them.

b. **Compliance certificates**: Importers must provide proof of conformity with Rwandan standards, verified by the RSB.

3. E-waste handling and refugee-specific considerations

a. **Collection systems**: In refugee camps, importers should collaborate with NGOs or local authorities to establish e-waste drop-off points, preventing unsafe disposal.

b. **Awareness campaigns**: Given the transient nature of refugee populations, clear instructions on returning damaged solar systems and batteries (to avoid open burning or dumping) are essential.

4. Penalties for non-compliance

a. Fines or import bans may be imposed on violators, particularly those who dump e-waste or import non-compliant goods.

Key takeaway for importers

Prioritize certified, non-toxic products and plan for end-of-life collection to align with Rwanda's strict e-waste rules. Partnering with local recyclers (e.g., EnviroServe Rwanda) can streamline compliance.