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## SUSTAINABLE SOLAR E-WASTE AND BATTERY TECHNOLOGY MANAGEMENT: A QUALITATIVE STUDY OF OFF-GRID SOLAR MARKETS ACROSS UGANDA AND SENEGAL

Given the growing demand and subsequent sales expansion across sub-Saharan Africa for affordable, modern solar household systems, the time to ensure a positive industry legacy is now.

### KEY FINDINGS

- Most product take-back is currently customer-driven, with customers bearing the cost of transport to return products, often without company-driven incentives to do so (discounts for an upgrade, etc).
- Consumers currently have little guidance on proper solar e-waste disposal, nor a clear understanding of the risks involved in local disposal, but are open to returning e-waste with minor incentives for transport.
- E-waste recycling facilities in Senegal and Uganda are limited due to undeveloped supply channels and limited processing capacity, and companies often pay high costs to ship used components to international service providers in the Middle East and Europe.
- Companies typically replace rather than repair faulty products under warranty, and products designed to be tamper-proof make individual component recycling more difficult, compounding company waste management challenges. A large portion of “faulty” products are returned to the manufacturer due to consumer misuse, not actual product performance.
- Given the nascency of the market, many solar home systems are still in operation, which has delayed the urgency of implementing solar e-waste management policies.

### INTRODUCTION

There has been a rapid and significant increase in the sale of household solar systems (SHS) throughout sub-Saharan Africa over the past decade, driven by an increasing number of private companies serving households and businesses. During this period of rapid growth, the off-grid solar sector is also working to ensure that its sales channels for SHS distribution across East and West Africa are sustainable, leaving behind a positive legacy for its rural customers. This research presents a qualitative exploration of the operational and logistical challenges that SHS distribution companies currently face in the efficient management of solar e-waste, to inform and assist companies in the sector in developing best practices. The study presents key insights from local solar companies operating across Uganda and Senegal, as well as a household survey exploring consumer behavior around solar e-waste collection, recycling, and repair.



## OVERVIEW OF SOLAR E-WASTE MANAGEMENT IN UGANDA & SENEGAL

Of the 65 stakeholders interviewed, 19 were companies operating in Uganda, 26 in Senegal, and 20 companies operating in multiple countries. 48 of the 65 were solar distributors, 13 were waste management companies, and 3 were battery manufacturers and distributors. The majority of companies interviewed provide warranties ranging from 1 to 5 years, with only a few offering repair or maintenance services outside of the warranty period. Beyond repair and maintenance services, half of the solar companies currently have e-waste management plans in place, with the other half planning to introduce one in the future. The challenges solar companies face in this area are varied:

- Lack of capacity to track product location and product/component performance after sale, particularly products out of warranty
- Lack of capacity to collect products at end-of-life and warehouse space limitations for storage once collected
- Lack of reputable local partners with processing facility capacity to outsource waste management and recycling
- Lack of consumer awareness about proper disposal protocol at product end-of-life, and the quality assurance challenges of off-brand products
- Lack of municipal or national regulations to support and provide guidance on sustainable e-waste management, solar or otherwise

Some challenges unique to the recycling businesses interviewed include:

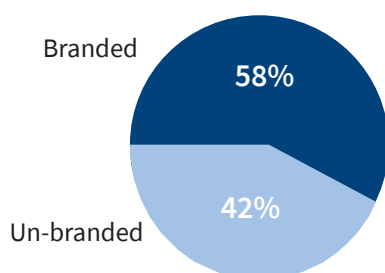
- Staff turn-over and retention: Multiple recyclers mentioned that they employ staff and provide e-waste management training, but staff will leave the company after a short time.
- Competition from the unlicensed or informal sector impedes the establishment of strong supply channels and subsequent profitability.
- Lack of processing facility capacity in-country, with most end-of-life product requiring recycling (Li-ion batteries, etc) shipped to Europe or the Middle East for processing at considerable cost.

There are promising business models being tested in the market, such as brand-agnostic collection programs built from established SHS distribution channels, second-use applications for li-ion batteries, and various corporate strategies to engage the informal sector,. But these efforts remain nascent.

## CUSTOMER PERCEPTIONS OF SOLAR E-WASTE IN UGANDA

A total of 320 households were surveyed in 40 villages across 8 different districts in Uganda. Of these, 160 households owned solar home systems; 58% of systems were branded with 42% non-branded. This distinction appears to correlate with some elements of user behaviours too as well; users of branded systems for instance were more likely to speak of 'responsible' disposal (56%) than those using non-branded systems (22%). Users of branded systems were also more aware of the residual value of solar e-waste; almost twice as many respondents using branded systems had awareness or previous experience of receiving cash incentives or discounts on future purchases in return for their waste products compared to users of non-branded systems.

Percentage of households interviewed with branded vs. unbranded solar home systems



Percentage of households interviewed that practice 'responsible' vs. 'irresponsible' e-waste disposal

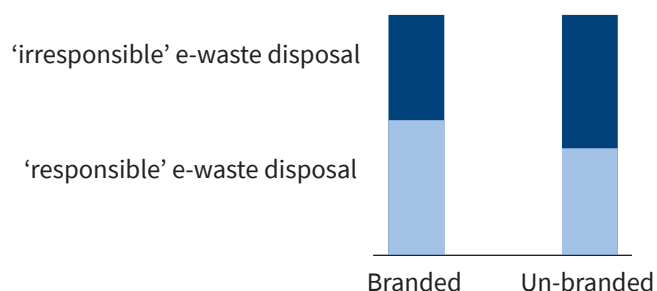


Table 1. Other highlights from the Uganda Consumer Household Survey

Question	Branded	Non-branded
Customers interested in seeking a product repair (by company or at independent repair shop)	85%	91%
Travel incentive required to return product to a collection, 10km away	10,000 UGX	10,000 UGX
Travel incentive required to return product to a collection, 25km away	20,000 UGX	20,000 UGX
Estimated value of broken SHS*	200,000 UGX	100,000 UGX

\*These figures correspond to roughly a third of what they paid for the products when new.

## RECOMMENDATIONS

### Industry

- **Business Model Innovation and Testing:** Given the nascent e-waste market and lack of waste management infrastructure in the region, the supply chain for e-waste recycling is in the early days of development and demand is high for SHS distributor and recycling company matchmaking. Incredible opportunity exists to streamline this supply chain, but various business models will need to be supported and tested to optimize the economics, with a focus on inefficiencies in device collection, refurbishment, and replacement, under current warranty and take-back programs.
- **Industry Data Collection:** The provision and tracking of reliable data on end-of-life product management and e-waste flow volumes will be critical in informing longer-term investment in programs that address solar e-waste at a systemic level. These data should focus on past, current, and predictive future volumes to best inform investment decisions.
- **Last-Mile Incentive Schemes:** Given the nature of rural distribution, initial subsidization or incentive schemes may be necessary to reach last-mile customers. Currently, the transport burden generally lies on the customer to return end-of-life products to a company collection facility, if a take-back program exists. Little incentive or guidance on return or proper disposal is currently provided.
- **Product Design for Recyclability:** Manufacturing and distribution companies will need to explore waste reduction strategies that can be employed at the early stages of SHS design and manufacturing to emphasize design for ease of recycling at end-of-life. Given the additional investment in product research and development required, this will not likely be adopted broadly until the cost burden of waste management hits a critical point. However, several industry leaders are taking steps in this direction with waste-minimizing design innovations.
- **Consumer Education and E-waste Literacy:** Most SHS customers have little knowledge of proper disposal of their products. Companies could play a key role in responsible product management by incorporating basic end-of-life disposal guidance into the information provided at the point of sale and through after-sales services. Enhance strong consumer feedback mechanisms to address user complaints, including issues related to system failures, performance fluctuations, and refurbished product quality assurance.
- **Sustainable Battery Management:** As the industry will continue to pursue battery solutions that provide SHSs at the lowest cost to the consumer, overall lifetime costs to the consumer and company need to be considered in battery selection, collection, and disposal, with a focus on product lifespan and recyclability.

## Government

- **Regulatory guidance must be established across the region to set a baseline of product responsibility standards** for manufacturers, distributors, and waste management companies. Third party implementing partners (such as SOFIES Group) are currently supporting the early stage development of e-waste legislation across East Africa, and more stringent guidance will only assist the industry in the future.
- **Opportunities exist around SHS product design-for-recyclability**, but these modifications largely need to also demonstrate cost-savings before being adopted by the industry, due to limited corporate research and development budgets. While these product design initiatives are limited by internal investment by companies, there is significant opportunity for third parties, such as Lighting Global, to provide guidance, recommendations, and incentives for material selection to improve recyclability.
- **Develop incentives to increase and enhance local e-waste recycling facilities**, especially for lithium battery recycling. Developing local capacity will depend on sound business models of e-waste companies, the establishment of stronger supply channels will need to be established to source sufficient material volume for economic viability.
- **Strengthen public-private partnerships aimed at increasing investment and expand government funding to attract private investment.** The private sector can accelerate investment in both high quality SHS and establish recycling plants for SHS e-waste management. Governments can support this work by creating an enabling policy environment and actively communicating with the private sector.
- **Support the establishment of extended producer responsibility as a business culture, including the following industry trends:**
  - Develop products that can be easily maintained and repaired and ensure spare components are locally available;
  - Develop strategies to take back faulty products and source local recycling capacity in-country;
  - Build partnerships with other manufacturers of electronic products to share the cost of collection, repair, transportation, dismantling, and recycling; and
  - Avoid the use of hazardous substances in the production and composition of SHS and battery technologies, enhancing product design-for-recyclability whenever possible.

This research study was completed by the ResilientAfrica Network, the University of California-Berkeley, and the University of Dakar, supported by the United States Agency for International Development (USAID).

