

The dark side of solar: How off-grid products are creating waste in Africa

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Solar panels on the back of a Fulani trader's bike encountered during Associate Professor Paul Munro's fieldwork. Credit: University of New South Wales

Household solar products are improving the quality of life for people living in developing nations. However, many off-grid solar products

function for less than four years. When they fall into disrepair, they become part of the growing problem of solar e-waste, bringing the sector's green credentials into question, says Scientia Associate Professor Paul Munro from UNSW's School of Humanities & Languages.

"Over the past decade, there has been a boom in the sale of off-grid solar products. Around 200,000 products were sold in 2010; by 2019, that had increased to more than 40 million products, or around US\$1.75 billion in sales," says the expert in energy poverty. "This has helped many energy-poor homes and businesses in Africa get access to electricity."

Solar lanterns and fans are replacing kerosene and battery-powered alternatives (which are both toxic and costly), while household solar systems are being used to power lighting, charge mobile phones, and run bigger appliances, such as televisions.

This explosion of renewable energy enables new opportunities; one man in rural Malawi said, "My kids are able to study during the night and the things that I thought impossible are now a thing of the past."

However, [it has compounded the issue of solar e-waste \(electronic waste\) with regulatory frameworks unable to keep pace](#), A/Prof. Munro says. "The sector has a responsibility to its customers and to the planet to consider products' afterlives."

Universal access to affordable, reliable modern energy by 2030 is one of the UN Sustainable Development Goals [SDG7]. "Access to energy is considered a high priority because it's intersectional," he says.

"You need energy to improve health and education outcomes to operate [medical technology](#) to save lives and enable reading in schools, access to computers to facilitate learning. So, energy is often seen as central to reducing inequities, enabling [greater opportunities](#) and meeting diverse

goals."

Increasing demand as well as the reduced cost of solar products and the proliferation of solar companies have been major drivers in the sector's rapid expansion, he says. Most of this growth has occurred in the East African region.

In 2022, A/Prof. Munro conducted fieldwork in Ghana. "We found in these off-grid areas, almost every household owned several solar products, but probably 95% of these products were more informally traded, rather than being sold by recognized off-grid [solar companies](#)."

The quality of solar products—both branded and informally traded—varies considerably, he says. "Most only last 3–4 years before breaking down. Some only last a few months. And even branded products only tend to have 1- to 2-year warranties."

While a formalized off-grid solar sector has been established with a peak body, the Global Off-Grid Lighting Association (GOGLA), the complex trade networks and consumption patterns in Africa present substantial barriers to addressing solar e-waste, he says.

Solar e-waste negatively impacts [local communities](#); waste and landfill sites, commonly located close to poorer communities, come with a financial burden, and the potential for hazardous materials to leak into the soil affecting agriculture.

"As such, neglecting solar e-waste undermines other sustainable development goals of inequality [SDG9] and responsible consumption [SDG12]," he says. "Supporting local repair economies and design-based practices of repair can help ameliorate the issue."

Local, familial and centuries-old trade networks

integral to distribution

A/Prof. Munro researches political ecology and energy justice, exploring how emerging technologies can help combat [energy poverty](#) in developing nations, such as Uganda, Kenya, Ghana, Malawi and Vanuatu. He is the Director of Sector Engagement (Climate) in UNSW Arts, Design & Architecture.

He witnessed the solar sector's dramatic change firsthand. After managing a project installing solar systems in refugee camps, health clinics and schools across Liberia in 2006, he co-founded Energy for Opportunity to support renewable energy infrastructure across sub-Saharan Africa. When he left to undertake research in forest governance, the sector was still in its infancy.

In 2017, he returned to Africa. "It was my first time in Uganda in about 13 years—I was taking students from UNSW—and there were just solar panels everywhere: on the ground, in the markets, being sold on buses," he says.

"For me, it was a fascination that this niche technology—across Africa [in 2007] we were only one of two organizations who were really doing work in this area—[but suddenly it] was just everywhere: masses [of] companies, huge investment ... all this activity [was] going on."

The formal off-grid solar industry has attracted more than US\$2 billion in investment since 2010, mainly from investors in the United States and North America. Ironically, however, it is the informal off-grid solar sector that has been the most effective in terms of distributing and installing solar products through local trade economies.

For example, in Ghana, door-to-door traders are using centuries-old trade routes, established for walking cattle across countries to the coast

to graze during the dry season. "Historically, it was fabrics or other household items [they sold], but as time has gone on, they've included solar products as part of their repertoire, usually [travelling] on foot or motorbike or bicycle," he says.

"And basically, they're dominating the trade. So there's these multimillion-dollar-backed venture capital companies trying to sell products and yet competing Burkina Faso traders are proving to be most effective in distributing products."

Additionally, consumer patterns in Africa are sporadic. Most families cannot afford an all-in-one household solar system or to hire a certified installer, says research partner Dr. Shanil Samarakoon from UNSW Engineering.

"[In Malawi, for example,] what we're finding is that households are often learning as they go along in terms of how to actually construct these systems ... it's a process of trial and error and a matter of buying these components as and when they can afford it," says Dr. Samarakoon.

"So it's this kind of constellation of components that form a system. So what we're seeing as we're visiting these households is often really DIY jobs in terms of installation."

Familial networks also play a role in the redistribution of solar products, he says. "People living in South Africa often ship poor-performing solar products back home to their families in rural Malawi for repair and/or use; so what is considered not functional in one context is considered good enough in another."

Navigating the right to repair in practice

To date, many solutions to solar e-waste have focused on recycling over

repair and design innovations, A/Prof. Munro says. "But recycling relies on expensive infrastructure, and it largely ignores the value of locally coordinated cultures, and local repairers' organic responses to the solar e-waste issue."

While the need for greater repairability is recognized and openly discussed, each country and context has different capacities, distribution patterns and legislation; this makes it hard to formulate a broad geographical response, he says.

The appetite for change is evident in the [GOGLA white paper promoting improved e-waste management](#). However, as a voluntary representative body, the GOGLA cannot enforce change.

Black-box technologies and closed proprietary hardware ecosystems are also perpetuating e-waste. Many start-up companies must recoup significant investment debt. "So they seal shut their products using tamper-proof designs, proprietary screws and circulating limited spare parts to protect their financial technologies, but that means they're not very repairable."

There's an inherent tension between business sustainability and environmental sustainability, he says. "Companies have digital handshakes and idiosyncratic cables so if you buy a solar TV from one company, it doesn't plug into another system... It captures customers and helps them make money, but it stops second-hand markets appearing and resists repairability."

Then there is the issue of how to repair and recycle solar materials on the ground, he says. Some companies have trialed repair solutions, but these too need to be profitable to be sustained. "There's a lot of informal repair work that's driven locally but this is more dispersed," he says. "[It raises the question then of] who's responsible for those products."

More research is needed to better understand these complex conditions, to raise the profile of the right to repair, and to influence companies and policies, he says. One option would be to develop a repairability rating system in line with existing quality mechanisms. "Often investors will look at this [information]. Often they are investing in these companies for their green image so that [kind of mechanism] would have currency."

However, uplifting local responses to e-waste, for example, by improving access to spare parts, incentivizing repairs or providing additional training, would likely have the biggest impact, he says.

He is currently examining—in collaboration with the off-grid solar organization SolarAid—opportunities for the [repair of off-grid solar products in Zambia](#) and the tensions between profit and sustainability associated with a market orientation.

"Despite the ingenuity and persistence of local actors, off-grid solar products are often more difficult to repair in the rural contexts [of the [developing nations](#)] they are designed for and marketed to," he says. "It raises the critical question of where the power lies in these highly globalized networks that design, distribute and profit from these solar objects and what the ongoing implications might be."

Provided by University of New South Wales

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