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The afterlives of solar power: Waste and repair off the grid in Kenya

Jamie Cross*, Declan Murray

University of Edinburgh, United Kingdom

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ABSTRACT

One neglected socio-cultural and political dimension to the rapid diffusion of solar power in Sub-Saharan Africa is the question of what happens when things fall apart. Investors in the small-scale renewable energy sector are increasingly concerned with the status of broken or non-functioning products and there is an emerging consensus around the need for centralised recycling systems as the solution to future flows of 'solar waste'.

But what does the afterlife of off-grid solar products look like from below? Grounded in anthropology, geography and economic sociology, this paper tracks the impact of off grid solar products through contexts of breakdown, repair, and disposal. Combining stakeholder interviews, a longitudinal survey of product failure rates in Kenya and ethnographic research at a repair workshop in the town of Bomet, we challenge narratives of energy transitions that fail to address the environmental consequences of mass consumption and present an alternative approach to solar waste embedded in cultures and economies of repair.

1. Solar things fall apart

'Any solar product is just like a big microchip, with many of the same components, materials and problems,' Sheila Davis, director of the Silicon Valley Toxics Coalition, told a workshop on solar waste at the Strathmore Energy Research Centre in Nairobi in 2015. 'If micro-electronic technology can't be recycled or repaired it is designed for the dump. Unless we think about these things now solar technology will end up in the same place.'

One neglected socio-cultural or political dimension to the rapid diffusion of solar power for domestic use in Sub-Saharan Africa over the past decade is the question of what happens to small-scale solar technologies when they break down. As the expansion of access to solar energy has become an important part of responses to energy poverty, precariousness and vulnerability, it has been easy to forget that solar photovoltaic technologies use similar constituent materials to those of almost any other electronic product or that solar panels and batteries contain materials that can have environmental and health impacts after use.[1]

Investors in the off-grid solar industry celebrate increased domestic access to photovoltaics as a net win for people living in chronic energy poverty (e.g. [1]). But is it possible that, in an industry committed to growth, the user and the environment may also lose out, or that accelerated transitions to decentralised energy provision via solar photovoltaics may also signal a point of no return for an e-waste burden across the Global South?

Sales figures offer some illustration of the potential scale of future electronic and electrical waste flows. Global sales of off grid solar devices reached 130 million between 2010 and 2017 [2]. Assuming half of these devices are discarded after 3–4 years, current estimates suggest that up to 26.2 million off grid solar devices could be out of use by 2017 [2, p. 175]. Such numbers suggest that the material politics of 'solar waste' needs to become part of the discussion about clean energy transitions in Sub Saharan Africa. The problem, we argue in this paper, drawing from research traditions in social anthropology, geography and sociology is no longer that *no-one* is talking about solar waste. The problem today is *how* solar waste is discussed, in what terms, and by whom.

Over the past five years questions about the sustainability and environmental impact of off grid solar energy systems and technologies have attracted increased attention from investors and bilateral donor agencies. In 2016, the UK's Department for International Development (DFID) commissioned a multi-country study to research electronic waste in 'Africa's off-grid renewable energy sector' [3]. The report concluded that the off-grid solar sector across 14 Sub Saharan African countries would produce 3600 t of electronic waste in 2017. Whilst this represented a fractional percentage of total estimated electronic waste flows it also put waste from off grid solar products on a par with

* Corresponding author.
E-mail address: jamie.cross@ed.ac.uk (J. Cross).

[1] Achieving the Global Transition to Energy Efficient Lighting Toolkit UNEP (2012) http://www.learning.enlighten-initiative.org/ebook/en_lighten_english_complete.pdf

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electronic waste from the mobile phone industry.[2] In response, the authors laid out a comprehensive pathway for action, focused on centralised take back, collection and recycling schemes.

The term 'solar waste' is problematic. As an umbrella term for a distinct sub-category within the larger, more established category of waste electrical and electronic equipment (known by the acronym WEEE) it can help to distinguish the responsibilities of key stakeholders, including manufacturers, producers, and trade associations, and to catalyse future action (from research to policy). But it also amalgamates into a single, apparently uniform category a diverse range of materials, component parts, metals and plastics.

When solar things break down they do not follow a single trajectory into electronic waste flows. Understanding what happens to off grid solar products at a moment of failure or breakdown requires us to consider solar waste in terms other than pure tonnage or potential financial value. Following broken things and their component parts as they move through homes, repair centres and office workshops offers an opportunity to see how material things accrue different values and meanings as they circulate [4,5]. Such an approach allows us to consider the 'afterlives' [6,61] of off grid solar products rather than focusing on what product designers and waste managers call the 'end-of-life'.

Our paper begins, in section one, by putting recent debates around energy justice into the context of debates about the 'end-of-life' of electronic equipment. We highlight the ways that a persistent framing of sub-Saharan Africa's energy transitions around narrowly defined goals of distributive justice (who has access) have neglected procedural justice (who determines the form and nature of that access). As we show, dominant justice framings have established the social and environmental costs of waste disposal as a 'market externality', diluting the responsibility of key actors and stakeholders. The terms of current debate about the management of solar waste presents new impetus for discussions of justice in renewable energy markets.

In section two we focus on the DFID-funded report and context in which it was commissioned. As we show, an emerging consensus around 'solar waste' rests on assumptions that both underestimate waste flows and volumes, and risk disrupting established economies of repair and re-use. Drawing on the emerging field of 'discard studies' we demonstrate the varied and productive range of activity that occurs around broken products, keeping materials in circulation long after breakdown, particularly in the Global South. Research on solar waste, we argue, must go to these other sites and not immediately 'to the dump'.

In section three we examine practices and relationships around solar repair and waste in rural Kenya. As the biggest market for off grid solar products in Africa Kenya is a crucial location from which to consider and engage with such questions. In 2016, alone, 8.07 million off-grid solar systems were sold around the world, 3.83 million of them in Sub-Saharan Africa [7,8]. Out of this, an estimated 32% of all solar equipment sold in sub-Saharan Africa, or 2.1 million devices, were sold in Kenya [7,8].

Like other scholars have done with fruit or furniture (e.g. [9,64) we follow solar things from the point they stop working as designed into homes and repair clinics where apparently dead things are given new lives or are reborn. We combine the results of a longitudinal survey with interviews with users, manufacturers, and distributors and ethnographic fieldwork at a repair clinic in the town of Bomet as well as company workshops across Nairobi. This research on solar repair points to the importance of a whole sphere of technical and economic activity that is not fully acknowledged in current approaches to waste, and brings to the foreground the perspective and practices of users, repairmen and technicians.

In conclusion, we question the emerging consensus on solar waste management in sub-Saharan Africa. We challenge the treatment of broken off grid solar products simply and straightforwardly as an electronic and electrical waste problem, and the emerging consensus on recycling as the primary solution. Instead, we argue that decentralised waste management strategies focused on re-use repair and product design present alternative means of reducing waste. Such insights provide considerable opportunities for the off grid solar industry to shape more sustainable transitions.

2. Not just distribution: energy justice beyond the lifetimes of electronic things

Attempts to drive low-carbon energy transitions are crucially about justice. But when people and institutions invoke notions of 'energy justice' they do so in specific ways, establishing the parameters of what justice looks like and how it may be achieved [10–12]. Nowhere, perhaps, is this more evident than across the network of organisations that comprise Sub Saharan Africa's off-grid solar industry.

In 2018 Sub Saharan Africa's off-grid solar industry included small, medium, and large enterprises involved in the manufacturing and distribution of off-grid solar products, at least two international membership based trade associations, as well as the bilateral development organisations, UN agencies, international financial institutions, charities, and social investment funds. Across this network, organisational policies, programmes and priorities share a common commitment to the UN's Sustainable Development Goal of access to clean, efficient, modern energy for all. They also share a common redistributive frame.

The UN's Sustainable Energy for All Initiative, the World Bank/International Finance Corporation's Lighting Africa programme, and DFID's Energy Africa programme, for example, are all formulated as redistributive responses to the unequal or uneven distribution of access to affordable, efficient, energy deemed essential for artificial lighting, clean cooking, and telecommunications. For-profit solar energy start-ups like d.light design and Greenlight Planet present themselves in similar ways, as redistributive actors, readdressing the distribution of access to energy technologies, infrastructures, and services through products imbued with an ethic of care [13,14].

These framings of a distributional justice 'deficit' identify common causes and have important effects. Across the off grid solar industry the unequal distribution of modern energy is presented as the outcome of a historic mismanagement of public resources and public infrastructures; the outcome of a chronic misalignment between the interests of bureaucratic or political elites and the needs or vulnerabilities of the poor; and the outcome of national policies that have imposed barriers or impediments to the frictionless growth of markets.

Framed in this way the market emerges as the only plausible primary mechanism for realising energy justice, and the work of organisations coheres around the strengthening of market ecosystems. Steps to this endpoint demand the rapid expansion or acceleration of distribution systems and logics. In this frame, the key measure of energy justice is who has access to solar products and what they do with them at the point of use or the moment of consumption; hence, perhaps, the proliferation of social impact assessment tools and methodologies focused on health, education and livelihoods.

Yet such a tightly delimited framing of justice is far from addressing the full distribution of harms and risks across an energy system.The acceleration of markets for off-grid solar might address the uneven distribution of energy services but what of the distribution of risks and harms across supply chains, and through product lifetimes? From the first experimental installations of solar photovoltaics in the 1980s until the early 2000s solar entrepreneurs in Kenya and their businesses were environmentalists committed to the local sourcing of parts, their local manufacture, their local assembly and the technical training of

[2] In 2014 waste from solar equipment in 14 Sub Saharan African countries constituted approximately 800 t of a total, estimated 460,000 t of electrical and electronic waste, the report showed [3: p. ii]. This share was expected to increase to 0.5% of total e-waste volumes by 2017, similar in weight to electronic waste from mobile phones over the same period [3: p. 27].