



THE UNIVERSITY *of* EDINBURGH

Edinburgh Research Explorer

Solar power and its discontents

Citation for published version:

Cross, J & Neumark, T 2021, 'Solar power and its discontents: Critiquing off-grid infrastructures of inclusion in East Africa', *Development and change*, vol. 52, no. 4, pp. 902-926. <https://doi.org/10.1111/dech.12668>

Digital Object Identifier (DOI):

[10.1111/dech.12668](https://doi.org/10.1111/dech.12668)

Link:

[Link to publication record in Edinburgh Research Explorer](#)

Document Version:

Publisher's PDF, also known as Version of record

Published In:

Development and change

General rights

Copyright for the publications made accessible via the Edinburgh Research Explorer is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy

The University of Edinburgh has made every reasonable effort to ensure that Edinburgh Research Explorer content complies with UK legislation. If you believe that the public display of this file breaches copyright please contact openaccess@ed.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.



Debate

Solar Power and its Discontents: Critiquing Off-grid Infrastructures of Inclusion in East Africa**Jamie Cross**  and **Tom Neumark** 

ABSTRACT

Since 2010, solar energy companies in North America and Europe have played a pivotal role in delivering clean, reliable and sustainable electricity to millions of people living off the grid across sub-Saharan Africa. However, today, off-grid solar energy in Africa is no longer seen as an unmitigated social and economic good. Inflows of private equity investment have led the employees and customers of off-grid solar companies to question the industry's commercial dynamics. Their critiques address the mis-selling of solar home systems and the technical limits of off-grid infrastructures for domestic production, framed both by dominant market paradigms and by relationships to nation, community and family. Drawing on ethnographic fieldwork in East Africa's off-grid solar industry, this study assembles these critical perspectives into a wider analysis of off-grid solar power as an adverse 'infrastructure of inclusion'.

INTRODUCTION

Solar energy companies have emerged as a key element in the physical, institutional, financial and digital infrastructures through which people living without electricity are included in circuits of social and economic welfare. Until recently, the relationships between these companies and their low-income, off-grid consumers in Africa have escaped critical scrutiny. The alignment of solar energy with political, economic and environmental agendas has granted the companies that make and market solar photovoltaic systems a relatively unchallenged role as agents of development.

The authors would like to thank the three anonymous reviewers for their comments during this article's development, as well as Kate Meagher for feedback and editorial support with the final article. In addition, the authors would like to thank interlocutors in Kenya, Tanzania and Uganda, as well as Germany, the UK and the US.

Development and Change 52(4): 902–926. DOI: 10.1111/dech.12668

© 2021 The Authors. *Development and Change* published by John Wiley & Sons Ltd on behalf of International Institute of Social Studies.

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

Policy makers and practitioners, for example, appear to have largely accepted the role of privately owned, off-grid energy companies as essential for meeting the United Nations' Sustainable Development Goals of inclusive growth through 'affordable', 'reliable' and 'sustainable' energy for all.¹

Between 2010 and 2018, approximately US\$ 1.64 billion in equity and debt (loans, venture capital and bonds) was invested in what financial analysts call 'global energy access markets' (Burger, 2019; Wood Mackenzie, 2019). While ostensibly global in scope, three quarters of this total, equivalent to US\$ 1.28 billion, was invested in companies operating in sub-Saharan Africa. Just over half of this total was channelled into East Africa and directed at off-grid solar companies whose core business was the sale and distribution of small scale (i.e. 3–150 watt) solar photovoltaic systems and solar powered appliances.² These inflows of investment in the infrastructures for off-grid electricity generation not only connected low-income populations to clean, renewable sources of power, they also connected people to a mobile financial infrastructure for consumer credit and debt. Between 2010 and 2018, half a million people had pay-as-you-go contracts with off-grid solar companies in East Africa (GOGLA, 2018). For much of the decade, this combination of decentralized solar energy with mobile payment systems was championed by energy companies, investors and international development organizations as an infrastructure of inclusion capable of lifting those living without electricity out of energy poverty.

Some recent social and economic studies of off-grid energy in Africa appear to leave the underlying terms of inclusion created by off-grid solar technology unexamined. Indeed, some researchers appear to have generally accepted the output metrics for social impact developed by the off-grid solar industry itself which consistently show off-grid energy companies delivering tangible improvements in livelihoods, educational outcomes and social mobility without the costs associated with fossil fuel (e.g. Kouton, 2021; Ojong, 2021).

However, a growing body of critical scholarship is beginning to re-examine these claims and the distribution of outcomes in the region's solar economy. Studies of technological innovation around energy access (e.g. Ockwell and Byrne, 2016) have concluded that a sole focus on hardware financing and private sector entrepreneurship is unlikely to meet the needs of poor users. User-focused studies have shown that the most affordable off-grid systems generate too little electrical power to provide more than the most basic energy services (e.g. lighting and mobile phone charging) and even these face problems of affordability despite complex microfinance and technical arrangements (Boamah, 2020a: 2; Boamah, 2020b; Samarakoon

1. See: www.un.org/sustainabledevelopment/energy/

2. One third of all investment in Africa's off-grid solar economy during this eight-year period (US\$ 564 million) was made between 2016 and 2018 and directed into just seven off-grid solar companies (Anderson, 2019; Wood Mackenzie, 2019).

et al., 2021). Attention to solar e-waste has raised concerns about the environmental impact of markets for low-cost consumer technologies and approaches to inclusive growth that hinge on non-local forms of mass production (Cross and Murray, 2018; Hansen et al., 2021; Kumar and Turner, 2020). Meanwhile, comparative research across sub-Saharan Africa, South Asia and Latin America challenges the idea that energy access for all is achievable (Kumar et al., 2019) and the presumption that access to solar energy alone can transform the lives of the poor (Furukawa, 2014; Kudo et al., 2019).

This article extends this body of scholarship by focusing attention on the structural relationships of power between solar energy companies and consumers, and the adverse terms of financial inclusion in the off-grid economy. Drawing on ethnographic fieldwork conducted across East Africa's off-grid solar industry, we show that academic scholars are not alone in critically interrogating the claims made for off-grid solar energy.³ On the contrary, the off-grid solar industry *itself* is an arena of growing concern regarding the terms of infrastructural inclusion. Across Kenya, Tanzania and Uganda, the growth of markets for solar power in the 2010s has been accompanied by growing discontent at the terms and conditions of market inclusion by managers, frontline staff and local populations. At a time when solar companies are seeking to extend their operations across western and southern Africa, frontline staff and their customers in East Africa are increasingly challenging the idea that the infrastructures for off-grid renewable energy in Africa could ever be affordable, and as such provide important insights into the dynamics of inclusion, exclusion and 'adverse incorporation' (Cholez and Trompette, 2019; Hickey and du Toit, 2013; Meagher and Lindell, 2013).

The International Energy Agency estimates that half of all new electricity connections in Africa will have to be off the grid in order to reach the UN's 2030 target for universal energy access (IEA, 2020). Realizing such ambitions will depend not only on physical infrastructures for off-grid solar energy but also on the social and financial infrastructures that enable people to use them. For two decades East Africa has been the most significant site of off-grid solar market activity in Africa. New models for delivering, financing and marketing solar power have all been trialled and tested here, before attempts were made to scale them up across the continent. Although

3. This article builds on Cross's ongoing research into the socio-material politics of off-grid energy across the global South (Cross, 2013, 2019a, 2019b, 2019c; 2020) and Neumark's long-standing research on welfare and technology in East Africa (Neumark, 2017, 2020). In addition, the article draws on 18 months of ethnographic research carried out by Neumark in Tanzania between 2018 and 2019. Our data include recorded interviews with over 50 current and former industry executives, managers, investors and analysts, systematic field notes of open-ended conversations with the employees of frontline solar companies as they sold, maintained, or repossessed equipment, and customers as they were connected to or used solar systems in rural locations.

off-grid energy companies in East Africa have yet to attract the kinds of organized public protest or civic action that we have seen directed at public energy utility companies in South Africa (von Schnitzler, 2008, 2013), we argue that closer attention to the entire infrastructural assemblage reveals the fault lines of future opposition.

We begin by outlining the evolution of East Africa's off-grid energy market and the social, technical and financial elements of an infrastructure for off-grid inclusion. Off-grid energy infrastructures can range from small, portable solar-powered lighting and charging devices to static solar home systems installed in individual households, to community-based solar microgrids that generate power for multiple homes. These infrastructures bring together the physical system for generating electricity off the grid; the microfinance systems and payment platforms that seek to ensure payment; and the work and labour of management executives, loan officers, marketing agents and repossession agents who help connect technical and financial systems to marginalized populations. To critique this infrastructure, as employees and customers do, is to question the ideas and assumptions that relate off-grid electrical connections to financial inclusion, and to interrogate what off-grid energy companies do, for what motives, and to what ends.

INFRASTRUCTURES OF INCLUSION OFF THE GRID

In the early 21st century, decentralized or off-grid solar energy systems are a familiar part of rural landscapes across East Africa. Solar panels can be found on the rooftops of health centres, schools and homes across rural Kenya, Uganda and Tanzania. Up until the early 2000s the installation of solar energy systems in the region took place largely within the moral economy of the 'development gift'. Large-scale, national public programmes of rural electrification undertaken by East African governments, with support from multilateral financial institutions such as the World Bank, were focused primarily on building utility-scale energy infrastructures to generate energy for regional electricity grids (Acker and Kammen, 1996; Sheya and Mushi, 2000; World Bank, 2018). By contrast, off-grid, solar infrastructures were largely funded by non-governmental and faith-based organizations, from charities to Pentecostal churches, and their installation often materialized or reproduced relationships of benevolence and patronage between the global North and South.

Only in Kenya was there also a flourishing rural market for off-grid solar systems, driven by the efforts of a small number of entrepreneurs (Jacobson, 2007; Miller, 2010). Over the past 20 years, off-grid solar energy systems have become big business across East Africa, driven by the activity of privately owned, for-profit companies. Today, off-grid solar photovoltaics are being used to power portable lighting and charging devices,

generate electricity for individual households and power entire communities. Private solar manufacturers, distributors and installers — from large corporations to cleantech start-ups and social enterprises — have become the principal vehicle for delivering access to clean, efficient, affordable energy (a key UN Sustainable Development Goal) for an estimated 138 million people who continue to live without a connection to the region's electricity grids. Prominent bilateral international development organizations — such as the UK Department for International Development (since 2020, the Foreign, Commonwealth and Development Office) and the US Agency for International Development — promote the expansion of off-grid markets as key to the inclusion of the poor in national and regional economies.

The 'infrastructural turn' in the social sciences has provided us with new analytical frames for understanding this relationship between off-grid electricity and programmes of social change. As Loloum et al. (2021: 3) observe, 'energy infrastructures are often taken for granted and assumed to be a socially neutral process of technological development'. Yet, they also operate as 'sites of expression for dominant ideologies, collective subjectivities and socio-environmental contestations' (ibid.: 4). Thus, as anthropologist Dominic Boyer (2014) proposes, what Foucault referred to as 'biopower' and 'biopolitics' is better understood as 'energopower' and 'energopolitics'. These terms, Boyer (ibid.) argues, more fully capture the relationship between energy, power and knowledge in modern modes of government concerned with the management of socio-economic life. As recent scholarship reveals, the sites of power and knowledge in African energy infrastructures extend beyond highly visible physical systems for the generation, transmission and distribution of electrical power to less immediately visible technologies for electricity metering and payment, and forms of expertise about electrification (Cross, 2016; Degani, 2017; Degani et al., 2020; von Schnitzler, 2008, 2013; Winther, 2008).

In one sense, the infrastructure for off-grid solar energy in East Africa is eminently physical. A standard polycrystalline solar photovoltaic module, for example, consists of layers of glass and silicon, ethylene vinyl acetate and metallic conductors, in an aluminium frame, linked by plastic coated copper wires to (depending on the scale of the system) a lead acid or lithium-ion battery via switch, control box or SIM card. Yet the operation of this physical array — and the marriage of East Africa's solar industry to programmes of financial inclusion targeted at underserved and low-income communities — is underpinned by a complex socio-technical apparatus for lending, collecting and monitoring repayments, *and* for producing creditworthy consumers. This financial infrastructure, with its forms of consumer debt and hire purchase loan arrangements, links precarious populations into wider circuits of capital and subjects them to forms of fiscal discipline that have been well documented by studies of micro-finance (Elyachar, 2005; James, 2014; Roy, 2010; Schwittay, 2011). As

these scholars and other scholars have described, the expansion of microfinance into new domains has also wrought significant transformations upon communities and individual lives, exacerbating existing inequalities and creating new ones (Dolan and Rajak, 2016; Fischer, 2018; James, 2014; James and Rajak, 2014). Against this backdrop, off-grid solar power can be an uncertain, ambivalent and potentially contradictory mechanism of inclusion. Rather than resolving inequities, the inclusion of low-income populations in off-grid energy markets has exposed people to new forms of financial and social discipline, and risks further entrenching forms of disempowerment, inequality and subalternity.

Mobile payment platforms and technologies that are changing the future of money (Maurer, 2015) have a synergistic relationship to portable off-grid solar devices, solar home systems and solar microgrids in East Africa, in ways that connect East Africa's fintech and cleantech sectors. Off-grid solar systems have provided the energy infrastructure for mobile banking in places that remain formally unelectrified, allowing people to charge and recharge the lithium-ion batteries that power every mobile phone and upon which mobile money platforms depend. At the same time, by connecting domestic energy expenditure (a major arena of household consumer spending) to mobile payment platforms, off-grid solar power has helped to bring a new generation of low-income customers and their payment histories into the orbit of a digital financial system that seeks to capitalize on hidden reserves of 'creditworthiness' (Donovan and Park, 2019). This combination of mobile money and solar power — that is, the combination of a physical apparatus for electricity generation with a technical and financial apparatus for lending and borrowing — demands that we bring energy companies into the analysis of financial inclusion.

A further, vital, dimension in what we might call an 'off-grid infrastructure of inclusion' has been forged in discourses of social entrepreneurship (Szeman, 2015). In the 2000s, East Africa's solar sector began to attract a new generation of graduate entrepreneurs from North American and European schools of engineering, management and business administration at the world's leading universities. Framed by liberal economic arguments that decried the failures of state-led planning to deliver 'development', they saw the private sector as better equipped to deliver development outcomes than governments and argued that market actors were better able to provide innovative, affordable solutions to the challenges of rural energy poverty and to deliver these efficiently, at scale. They viewed the gradual expansion of big, state electricity grids into rural Africa as too cumbersome, inefficient and slow to bring about meaningful reductions in energy poverty. They were motivated by opposition to fossil fuelled economic growth, seeing and seizing an opportunity to replace the use of 'dirty' wood fuels, refined oil and diesel with cleaner, renewable technologies that could meet people's needs for cooking, artificial lighting and entertainment. Many were

motivated by critiques of 20th century management and business strategy, seeing in the creation of consumer markets for off-grid solar energy at what became known as the ‘bottom of the economic pyramid’ (Prahalad, 2006: 118) as an opportunity to realize a triple bottom line: delivering social, environmental and economic good.

FORMATTING INCLUSIVE INFRASTRUCTURES

In the early 2010s, East Africa became a focal point for efforts to use mobile money and lending platforms to drive the growth of off-grid solar. The top recipients of financial investments in East Africa’s solar industry at the end of the 2010s were all founded within a seven-year period, between 2005 and 2012.⁴ It was a moment that saw efforts to re-embed moral values in financial infrastructures, systems and flows across many parts of the global economy (Gleeson-White, 2015), including the solar industry. Getting solar energy into the hands of cash-poor consumers at scale required experimentation with an array of financial and social arrangements and off-grid solar companies in the region worked to build partnerships with local distributors, recruit salespeople, manufacture cheaper products and explore novel forms of consumer finance.

Off-grid solar markets involve two prominent forms of physical infrastructure, tied to different models for consumer financing and debt. The first is a stand-alone ‘home system’, usually consisting of a rooftop mounted solar panel, battery, controller and light bulbs. The financing model for these stand-alone systems has coalesced around hire purchase payment agreements. This model sees customers make an initial down payment on a system, followed by regular payments over a period of years, after which they own the system outright. Mobile payment systems, combined with mobile enabled control systems in solar technology itself, have considerably de-risked investments in this business model by allowing solar companies to develop credit profiles for customers based on detailed records of their payment histories, reducing problems of uncertainty and delayed returns for investors.

The second kind of physical infrastructure is centred on solar-powered microgrids, which are effectively decentralized power plants that generate electricity off-grid, distributing power to households and businesses via lines and cables. Customers pay only for the electricity they use through smart meters connected to mobile payment systems. Mirroring efforts to build consumer markets for electrical power in the early 20th-century UK and US (Bakke, 2016), solar microgrid companies in East Africa have worked

4. These include: d.light and Greenlight Planet, Zola Electric (previously known as Off-grid Electric, and before that M-Power), M-KOPA, Azuri, BBoxx, Simpa Networks and Nova Lumos.

to stimulate energy demand amongst their rural customers by selling them new electronic devices. At regional trade fairs for the industry, solar micro-grid companies could be found showcasing new domestic and agricultural technologies — from televisions and refrigerators to water pumps and rice husking machines — that they market to customers under hire purchase consumer finance arrangements.

The promise of these off-grid energy infrastructures has attracted the attention of diverse investment communities. Between the mid-2000s and early 2010s, impact investors led the expansion of financial flows into ‘bottom of the pyramid’ off-grid solar companies in Africa. These funds represented a mix of wealthy individual philanthropists, specialized ethical funds, cause-oriented endowments and family trusts that defined their interests around the pursuit of social and environmental value alongside, and distinct from, financial value (Kish and Fairbairn, 2017). As one North American executive put it, success was measured in terms of ‘quality of life improved, per dollar’ and the ‘absolute lowest cost stepping stone that you can get out there at a scale where it’s meaningful’.⁵ Small-scale, solar-powered systems for lighting and mobile phone charging appeared to represent precisely this lower cost ‘stepping stone’.

As off-grid solar companies sought to scale up their operations, however, they also courted (and were courted by) US- and European-based traditional private equity and venture capitalist investment funds. Investment funds — representing institutional investors and high net worth individuals — were drawn to off-grid energy markets by the poor performance of other investments following the 2008 global financial crisis and the promise of growth in emerging economies. Many had begun to embrace services and technologies associated with environmental benefits under the umbrella term ‘cleantech’, adding this as a third plank of their technology portfolios alongside ‘infotech’ and ‘biotech’ (Goldstein, 2018: 23). This pattern of investment culminated in the massive inflow of private venture, debt and asset-backed investment capital into East Africa’s solar economy between 2015 and 2018, driven by the prospect of market growth underpinned by consumer credit and debt.

Off-grid solar companies measure the inclusiveness of energy infrastructure in simple terms: number of units sold and number of customers connected. Such metrics fail to address or account for the deeply precarious terms of inclusion. Long-term consumer credit agreements and the use of smart metering systems for electricity use mean that inclusion in off-grid markets is always dependent on a household’s capacity to pay. Accounting for this precarity reveals that inclusion in off-grid energy markets often takes place on adverse terms, a realization that is emerging as much *within* as outside the industry.

5. Skype interview, founder and CEO of off-grid solar company, 2 September 2019.

‘IT’S ALL ABOUT THE MARKET’: CORPORATE CRITIQUES OF OFF-GRID INCLUSION

In April 2019, one of the largest companies in Africa’s off-grid solar energy industry, Mobisol, filed for preliminary insolvency in a German district court. The Berlin-based company’s business model — one that hinged on customers in its East African markets buying solar equipment on a hire purchase finance agreement and making repayments over a mobile phone — was, the *Financial Times* reported, simply ‘too good to be true’ (Dizard, 2019). Founded in 2010, Mobisol was one of the highest profile companies to benefit from this inflow in investment, raising a reported US\$ 80–90 million over the decade, two thirds in equity and one third in debt (ibid.). Under the banner ‘Plugging in the World’, the company’s founders had been a charismatic presence at industry trade fairs, showcasing to potential investors their ability to monitor debt repayments from customers in East Africa remotely; inviting people to zoom into their customer’s energy usage data and payment profiles in real time. But by the end of the 2010s, facing increasing competition from lower-cost products and increasing numbers of customers who could not afford to repay their loans, the company’s business model no longer appeared commercially viable.

In 2018 Mobisol repossessed 5,700 solar home systems in Tanzania, of which 345 were in the district of Arusha alone. At the end of that year, the company’s Arusha office advertised for a new Head of Credit. The successful candidate, according to the advertisement, would share ‘a passion to plug in the world’. Yet alongside ‘reviewing and developing the company’s credit approval policies’ the tasks in the job description also listed participating in ‘ad hoc projects of an investigative or trouble shooting nature on specific customers’. As the advertisement implicitly acknowledged, ‘plugging in the world’ also occasionally required the world to be ‘unplugged’.

Following the company’s insolvency in 2019, investors and lenders appointed a team of consultants to restructure the European arm of the company, whilst its subsidiaries in Kenya, Rwanda, Tanzania and Uganda continued to operate. Within months the entire company, its subsidiaries and assets were bought by a French electric utility company. To observers and analysts of Africa’s energy sector, Mobisol’s collapse offered a cautionary tale for investors, one that raised fundamental questions about the viability and risks of selling off-grid solar energy on credit to the rural poor (see, e.g., *African Energy*, 2019; Alliance for Rural Electrification, 2019; Pombo-van Zyl, 2019; Sanyal et al., 2019). But Mobisol’s insolvency also exposed other questions about the politics and economics of Africa’s off-grid energy sector.

The Mobisol saga threw into stark relief shifts that were already underway in the region’s off-grid sector, as the promise of a connective,

inclusive infrastructure confronted the economic realities of energy markets among precarious East African consumers. In late 2018, during an interview in the boardroom of one of Tanzania's largest off-grid solar companies, a European man, the Head of Sales, got to his feet to summarize the company's strategy on a whiteboard.⁶ At the top of the whiteboard he wrote, 'all', and then drew a line vertically below it. 'What we're doing', he said, 'is taking out the customers'. 'First we take out those on the grid'. He drew an arrow coming off at a right-angle at the top of the line, and wrote, 'grid'. 'Then we take out those who already have solar'. He drew another arrow, writing 'solar'. 'Then we take out those who live in poverty'. He drew a final arrow pointing at the bottom of the board and wrote the word, 'poor'. He stood back. 'After that', he explained, 'we are left with our addressable market'.⁷

Like other solar companies that had once been committed to selling affordable energy systems to low-income rural populations as an alternative to the grid, this company in Tanzania was now exploring the sale of larger, more expensive systems as a backup for people already connected to the grid. Providing off-grid energy to precarious populations had lost its shine. Underpinning this restructuring of goals was an ambitious commitment to growth. As the Head of Sales put it, describing his strategy: 'Impact investors are not going to take you to four countries'.⁸ By contrast, he explained, investors who placed less (or little) emphasis on the social or environmental bottom line allowed the company to realize its untapped potential by scaling up their operations beyond the poor.

In 2019 similar shifts in strategy were being discussed in corporate headquarters across the sector. At the end of an interview in another off-grid solar company headquartered in Tanzania, the in-house Head of Credit emphasized the company's shift from 'bottom of the pyramid' markets with a rhetorical question, producing not only a crude representation of energy poverty in Africa but also a grandiose description of their technology: 'Are we selling Porsches to people in mud huts? Should we even be selling to people in mud huts?'.⁹

The shift to a more overt focus on growth left people with strong commitments to the solar industry's social and environmental goals disillusioned. One senior woman executive put it bluntly: 'It's funny, if you listen to our new financial board, the way they talk. It's all about the market. They don't even mention electrification anymore. It's all about how many billions the market is. The reason why we all joined the company is no longer the case'.¹⁰ Another executive described how, for several months at the

6. Interview, Head of Sales of off-grid solar company, Arusha, 18 May 2018.

7. Ibid.

8. Ibid.

9. Interview, Head of Credit, off-grid solar company, Arusha, 22 February 2019.

10. Interview, senior executive, off-grid solar company, Arusha, 27 February 2019.

beginning of 2019, they had been embroiled in a conversation with colleagues about whether their company was still ‘mission driven’ or whether it had become ‘profit driven’.¹¹ It is very easy for a company to imagine that they are shifting the focus away from purely social goals only temporarily, he explained. ‘But a lot depends on the investors ... they are not investing for this’.¹²

Reflecting on a decade of growth, both the senior managers and the executives we interviewed across the global solar industry described a similar process: one in which the pursuit of social, environmental and economic goals in the solar industry had been gradually displaced by the pursuit of financial returns on investment. For many, new inflows of investment had brought about something greater than simply ‘mission drift’ (Jones, 2007); it had led to a wholesale change in purpose and values. Some interviewees described how their companies appeared to have abandoned social commitments to reduce chronic energy poverty and no longer appeared to be interested in achieving universal access to electricity at all. Instead, these companies now appeared principally or primarily concerned with the commercial value of the energy market’s share and sales.

These changes were accompanied by simmering executive discontent. As one North American engineer employed by a solar company in Tanzania put it: ‘When we started, we had this non-profit mission to help rural customers in energy poverty, but the direction has now changed. It used to be that everyone was interested in getting people up the energy ladder. That proved to be a very difficult thing to do and now investors are expecting certain things’.¹³

Such managerial discontent at shifts that prioritized shareholder and commercial value was mirrored by some in the investment community. Impact-oriented investors whose financial and ideological commitments to the social and ecological good had been pivotal to the sector’s early growth, smoothing the way for the penetration of venture capital, now raised concerns about how a creeping focus on growth was affecting the viability of their mission. At the end of 2017, for example, three outgoing directors of Ceniarth, a UK-based impact investment fund, issued a stark warning about ‘current commercial dynamics in energy access markets’ on a widely read business and development blog (Neichin et al., 2017). Increasing pressure from investors for companies to grow, they wrote, was likely to see companies relax their credit criteria and ‘risked a wave of over-indebtedness’ (ibid.).

These strands of corporate disillusionment all emerged from and were firmly located within the discursive frame of market-led development (e.g. Chatterjee, 2016; Lewis, 2019; Sharma, 2017). They remained committed to

11. Interview, senior executive, off-grid solar company, Arusha, 22 March 2019.

12. Ibid.

13. Interview, senior executive, off-grid solar company, Arusha, 6 December 2018.

models and ideologies of social entrepreneurship and impact investing, and invoked, with nostalgia, a utopian moment of 21st-century entrepreneurship when the pursuit of social, environmental and commercial values seemed perfectly aligned. Such views also reflected social situatedness and privilege — these impact investors enjoyed educational qualifications, transnational links, financial independence and citizenship that afforded them the possibility of articulating their views in English-language blog posts or industry comment pieces and of exiting the industry by resigning from their jobs.

Whilst some critiques of the solar industry are shaped by this globally circulating market frame, others are more closely embedded in the social, historical and political particularities of East Africa. When many off-grid solar companies establish offices in East Africa they invest time and effort in cultivating strong relations with local- and national-level political leaders (Neumark, 2020). As these companies have matured, or have focused on meeting more aggressive sales targets, their founders have frequently neglected these relationships, sometimes seeing them as barriers to rapid market expansion. Off-grid solar energy corporations are not unique in seeing local leaders as a vestige of out-dated or cumbersome bureaucracies. However, as solar companies have sought to bypass or work around political and economic relationships with these figures, they have also created the grounds for mutual distrust.

In the early 2010s, one Tanzanian man — the founder of a national NGO who considered himself to be a social entrepreneur — was recruited to the board of a European-owned solar company that was seeking to establish a foothold in the country's rural markets. Motivated, in his words, by patriotism and moral duty, and by the conviction that off-grid energy could transform people's lives, he provided political connections by travelling across the country to meet local-level government authorities and vouching for the company and its market ambitions. By the end of the decade, however, he no longer felt his advice was valued or needed. Where he had once felt like a respected advisor he now felt 'like an employee', and his trust in the company had collapsed. Where he once thought they were selling solar to the poor, he now described them as 'mis-selling solar to the poor'. 'I cannot, will not, and will never cheat my government', he said. 'But' he added, 'foreign-owned off-grid solar companies: they need to be cheated'.¹⁴

In contrast to their European and North American colleagues, Tanzanian managers in solar companies with detailed knowledge of company budgets, finances and costs also voiced concerns about the extractive nature of off-grid financial flows. These critiques often invoked the idea of electricity as a public rather than a private good and frequently pointed towards historic relations of power between actors located in the global North and South. In

14. Interview, off-grid solar company board member, Arusha, 5 September 2019.

2019, for example, a Tanzanian electronics engineer employed by a major regional solar company spent several hours off-duty to do a detailed comparison of the costs incurred by a customer buying a solar system on finance and the costs of buying a system outright. His conclusion was blunt: ‘off-grid solar companies were not just benefiting from the poor’, he said, ‘they are making a killing out of them’.¹⁵ Another Tanzanian man, who spent the best part of the 2010s as a senior executive in a European solar company, tried putting himself into the shoes of a private investment fund as he sought to understand and analyse their motives: ‘Things have moved away from a social mission to only be about profit. The investors have changed things. It is not that investors from a private fund in North America don’t have a mission or social ideas, but they want to know “how will this money that we are putting into Africa come back to us?”’.¹⁶

Whilst young, educated, middle-class Tanzanian professionals working in the solar industry articulate these concerns in private, few do so in public, acutely aware of the precariousness of the labour market. Some acknowledge the compromise: ‘It was hard, it was really hard’, one young Tanzanian solar energy manager said, describing a deep frustration at watching the company she worked for shift its focus away from energy poverty. ‘But we had to survive, and also I needed a job. So, I came to accept it’.¹⁷ Others acknowledge the ways that their own economic futures have become fused with those of their employer. As one Tanzanian solar engineer said: ‘I want [the company] to still be there, because maybe my child will want to work there, who knows what will happen in the future? And even for my own CV, if you show someone you worked somewhere for five years, and then you say the company does not exist anymore, it’s not good’.¹⁸

Such comments provide an important reminder that criticism of business practices within solar energy companies serving low-income markets in East Africa can be tempered by the relative insecurity of some employees, as well as their relationships to others. Here, the terms of discontent were framed by expectations that institutions, communities, households and individuals act within wider networks of sociality, obligation and kinship (Neumark, 2017; Rodima-Taylor and Bähre, 2014).

INCLUSION BY REPOSSESSION: UNPLUGGING THE POOR

One February morning in early 2019, at a little cafeteria in Arusha, Tanzania, two Tanzanian loan officers employed by one of the country’s largest off-grid solar companies met for a day of repossessions. Drinking tea, one

15. Interview, electronics engineer, Arusha, 12 March 2018.

16. Interview, former executive, off grid solar-company, Arusha, 5 October 2019.

17. Interview, solar energy manager, Arusha, 10 April 2019.

18. Interview, solar engineer, Arusha, 24 April 2019.

of them explained the rationale. He said that the company he works for invests a lot of time assessing the capacity of people to repay the loan on the solar home system package the company sold. 'Other solar companies were not so scrupulous', he said. 'But all companies', he explained, 'sometimes found themselves with people who did not make their monthly repayments; people who were either "unwilling" to repay or who had found themselves with "insufficient capacity"'.¹⁹

Depending on the company, defaulting on a payment would trigger efforts to lock the system (either in person or via a remote-control mechanism), preventing its use. Continued failure to pay would result in an attempt to physically recover the equipment. Travelling across the countryside by private car, on hired motorbikes or by public transport, the loan officers would look up customer details on their smartphones whilst trying to locate their home (and the solar system they had bought on credit). Often having to ask multiple times for directions, they would eventually track down the customer or a relative of that person to give them the opportunity to repay the outstanding debt on the spot. There was space for negotiation over the amount and the timing, with the loan officers seeking payment over repossession. '*Lengo ni malipo*' or 'the aim is the payment', as one of them put it in Kiswahili. If no payment was forthcoming, however, the installed system would be taken back. Cables and wires were ripped unceremoniously from internal walls, electric lights and appliances disconnected, solar panels were lifted from rooftops, the solar batteries and inverters removed. The process might last up to an hour, during which members of the public might come over to speak to the repossessions team, setting up impromptu sales opportunities and prompting them to hand out product leaflets.

In some cases, a household that was subject to repossession seemed less plagued by economic circumstance than by dissatisfaction with their purchase. Reflecting on such cases, the loan officers would conclude these customers were simply 'unwilling to pay'. In other cases, however, upon arriving at a one- or two-room, mudbrick home waterproofed with plastic bags, the loan officers were visibly shaken by the poverty of their consumers. On one such occasion, after removing and repossessing a solar home system and television set from a woman in front of her child, one of the loan officers reached into their pocket, took out a TZS 2,000 note (just under US\$ 1) and handed it to her. 'Come the rainy season, they are going to be in a lot of trouble with that house', he said.²⁰

Towards the end of the 2010s, energy analysts working for independent think tanks and third sector research organizations began to question the impact of indebtedness among off-grid consumers and the limits to inclusion in the off-grid economy. Reflecting on the practice of remotely locking out or shutting down systems when pay-as-you-go solar customers did

19. Interview, loan officer, Arusha, 7 February 2019.

20. Interview, loan officer, off-grid solar company, Arusha, 7 February 2019.

not keep up repayments and the increase in repossessions, one industry report described this as, ‘the dark side of pay-as-you-go solar’ (Waldron and Swinderen, 2018). In Arusha, the centre of the off-grid solar industry in Tanzania, personal concerns with the ethics of the solar industry led some corporate managers to use these research studies as the starting point for their own investigation into their business. One senior manager, for example, privately carried out an analysis of their company’s database on default rates, seeking to correlate their in-house figures with the conclusions of a research study carried out by the Consultative Group to Assist the Poor (Zollmann et al., 2017).²¹

Many managers saw the repossession of solar equipment as illogical, resulting in a net economic and reputational loss for both company and customer. repossession meant customers lost the payments they had made; they lost a source of domestic lighting; and, for those with systems that powered radios and televisions, they lost an important source of entertainment and ‘connection’ to wider publics. Most challenging, perhaps, was that customers also lost face; for many, repossession was a source of deep shame. Meanwhile, the company lost money as it covered the process of recovering and disposing of the system. In storage, the system’s battery would degrade, and as a second-hand unit, it would never sell for even close to its original cost. According to one solar company manager with detailed knowledge of the firm’s finances, the full cost of repossession could be as much as twice the original cost of the equipment. His conclusion was stark: ‘I don’t think we should even be repossessing. In asset finance, the idea is that you repossess that asset and sell it on, to recoup the costs. But we are not doing that. The systems are just going into a warehouse and staying there’.²²

The critiques of many managers remained embedded within an orthodox economic paradigm that presented impoverished customers as rational decision makers. The root cause of customers missing payments was seen either as economic — the result of short-term cash flow problems or household shocks — or logistical — caused by a misunderstanding of the payment terms or a technical problem with mobile money systems (Zollmann et al., 2017). By contrast, the critiques of repossessions articulated by frontline Tanzanian staff, repossession officers and customers themselves often recognized unpaid debts as the outcome of more complex obligations and social relationships, bringing a wider constellation of non-market actors into this frame.

The repossession of solar equipment depends on the ability of off-grid companies to secure and enforce their property rights. In much of rural East Africa, this relies less on formal, state-backed mechanisms of legal enforcement (like the police) than local systems of ‘relational contracting’ through local recognized or legitimate authority (Neumark, 2020).

21. Interview, Head of Credit, off-grid solar company, Arusha, 30 January 2019.

22. Interview, solar company manager, Arusha, 27 March 2019.

Customarily, in rural Tanzania, for example, a village chairman (*mwenyekiti wa kijiji*) might have been called upon as a third party to validate contracts like this. However, instrumental approaches to relational contracting have sometimes proven problematic in the context of repossessions. One young solar company staff member, for example, described a problem that arose during his attempt to repossess a solar home system when his company's contractual claim to the system was contested by a local-level political authority. 'There was this time when a certain chairman refused to cooperate', he explained. 'The chairman told us, "When you entered into a contract with that customer, you didn't coordinate with us the village leaders. But now if you face a challenge, you return here and expect us to resolve it"'²³

As we explore below, the discontent articulated by employees, managers and investors within the off-grid solar industry is mirrored in the discontent of customers themselves, as they raise questions about the inclusive benefits of solar power and the developmental objectives of private energy companies.

'IT'S JUST POWER FROM THE SUN': THE CONSUMER CRITIQUE OF OFF-GRID SOLAR

In mid-2018 engineers working for a private solar microgrid company arrived in a village in central Tanzania. Few residents appeared to have ever heard of the company, even though its managers had visited the village earlier that year with the goal of securing consent for the project, and they began to investigate. Residents observed that the sides of trucks carrying electricity poles into the village displayed the label of the Tanzanian Rural Energy Agency (REA) which led them to wonder if the project was in fact funded by the state-owned electricity utility company Tanzania Electric Supply Company Limited (TANESCO). Many were sceptical that a private company alone could deliver what was promised — affordable, reliable electricity — and they raised questions about the extent of the government's involvement.

'Reliability' is central to the UN's goals for universal energy access by 2030.²⁴ The UN uses the word to mean a consistent flow of electrons from the point of electricity generation to the point of demand. In East Africa, off-grid companies have adopted the meaning to promise customers the dream of '24-hour electricity'. To customers in rural Tanzania, however, reliability is not just about the continuity of supply; it is also about whether energy systems can be depended upon to produce long-term socio-economic outcomes at a community and national scale. Historically, TANESCO, with support of foreign donors, has taken responsibility for these energy systems.

23. Interview, loan officer, off-grid solar company, Arusha, 22 January 2019.

24. For more information see: www.un.org/sustainabledevelopment/energy/

‘Is there a relationship between the company and TANESCO?’, one of the village secondary school teachers, a young man, asked his neighbours. ‘And if not, why did the poles arrive on a TANESCO vehicle?’²⁵ The construction work was visible from the teacher’s home. From the front room, which was little more than a porch, a wooden-framed sofa faced outwards with a view through the doorway. From the sofa the teacher watched carefully as the solar engineers in bright orange boiler suits dug holes for electricity poles throughout the village. ‘I can’t yet say if I trust or don’t trust the company. People are just waiting to see what will happen’, he said.

Eventually the company finished installing a hybrid solar-diesel power plant and connected 200 households via a network of distribution lines. The company erected a village welcome sign with the name of the company and its logo in large print, and in much smaller letters below it, the name of the village. Like other locations across central Tanzania, the arrival of this privately funded, off-grid energy infrastructure prompted a barrage of questions from new customers. ‘Will solar energy be as cheap or reliable as state grid electricity?’, people asked. And, ‘would this off-grid system be able to power the same kind of equipment as a grid connection?’²⁶

When the microgrid was first activated in the village, one new user made an initial payment of TZS 1,000 (around US\$ 0.50) ‘just to test it’.²⁷ He turned on the lights and equipment in his shop and quickly discovered that the cost of electricity was much more than he expected. His payment lasted less than half a day, making off-grid solar energy 20 times more expensive than the cost of mains electricity from TANESCO. He challenged the company’s engineers, asking what they could do about it, only to be told that they ‘couldn’t do anything’. The engineers were well aware of the problems concerning the price of electricity but were powerless to make any changes.

Other customers also began to test the new power supply and the company that had installed it. The village’s most prominent entrepreneur, who made his money renting houses and shops, plugged in a high-powered welding machine and turned it on to test the power. The equipment shorted (it required a three-phase alternating current, but the microgrid was single phase). A few months later, he installed an alternative diesel-powered generator plant to power his machinery.

Other customers in the village began to question the company’s claims to provide electricity that could be relied upon for development. Many felt that the installation of the microgrid had now blocked any possibility that the Tanzanian government would extend the mains electricity grid to the village, and they began discussing ways in which they could get the company to come back and remove the power plant altogether. One young man in the village captured the wider public’s mood: ‘This electricity is just for

25. Interview, village secondary school teacher, central Tanzania, 16 August 2018.

26. Interviews, village locals, central Tanzania, 16 August 2018.

27. Interview, village shop owner, central Tanzania, 15 August 2018.

emergencies', he said. 'It can power lights, but it can't power factories or industry. It's just power from the sun!'²⁸

After several months of dissatisfaction and outrage at the cost of electricity from one of the leading pay-as-you-go solar companies, another local businessman articulated the sum of people's discontent: 'This company is not here to help the people, they are here to make super-profit. Super-profit! It is exploitation', he said. 'Are they all the same? Is one company the same as another?'²⁹

Such questions were illustrative of a widespread commitment, common across rural Tanzania, to the idea that the provision of electricity should be a public service and that electricity should be a public good. It is an idea rooted in the social and economic history of post-colonial modernization that has seen successive East African governments drawing on domestic tax revenues, borrowing and using foreign aid resources to keep the price of electricity low. Similar ideas can be found elsewhere. From rural India to Papua New Guinea, expectations that energy infrastructures can act as infrastructures of inclusion are shaped by ideas about the symbolic power of electricity to 'connect' people to the state (Cross, 2019c). Against this backdrop, however, the actual, lived experience of decentralized solar power rarely meets people's expectations of electric modernity, of full electrification and modern energy services that can reliably drive upward social and economic mobility.

TAMPERING AS CORPORATE CRITIQUE

In February 2020, a court in Uganda's capital, Kampala, remanded the employee of a US-based off-grid solar company in prison on two counts of illegally accessing and modifying a solar unit to generate electricity for lighting and charging without paying for it (Ndagire, 2020). The court case pitched a 22-year-old man against his former employer, one of the world's largest and most successful off-grid solar companies. The man was accused of tampering with the pay-as-you-go solar system, one that was designed to allow customers to pay off the system in instalments over a period of 24–36 months. Built into the electronic circuitry was a remote monitoring system that allowed the company to track and monitor payments. The suspect was accused of modifying the motherboard and bypassing the monitoring software system so that customers could not be pursued for final payments. News of the court case percolated through the solar power industry. 'Our company's WhatsApp group suddenly went crazy', one executive at another

28. Interview, local businessman, central Tanzania, 17 August 2018.

29. Interview, local businessman, Arusha, 27 August 2018.

firm explained. ‘I mean, what were they thinking, do they really want to get a reputation for suing their consumers?’³⁰

This legal case, understood by Ugandan journalist Betty Ndagire as the first of its kind in East Africa, marked a new front in a long-standing struggle by solar companies to restrict access by consumers to the internal workings of their solar equipment.³¹ Across the region, customers have repeatedly responded to the real costs of solar energy with non-payment or by attempting a material workaround or hack, opening up pay-as-you-go control boxes in solar microgrids and solar home systems in an effort to bypass the remote control system and use electricity for free.

In response, off-grid solar companies in East Africa have continuously redesigned their systems to prevent customers from accessing the internal components. New enclosures, fittings, screws and welds have been built to make the internal mechanisms of smart meters ever less accessible. Meters have been updated with new firmware and internal trip switches that are designed to shut off electricity automatically and alert operators remotely if they are opened. These efforts have even extended to the transmission lines connecting solar powered microgrids to homes, as companies attempt to forestall electricity theft by making access to the cables themselves as difficult as possible.

One solar microgrid company in Tanzania, for example, experimented with burying transmission cables in the ground, which was both cheaper (because there was no need to invest in poles) and more energy-efficient (because the ground is cooler). However, on finding that this made it easier for people to access the lines, the company reverted to more costly and less efficient overhead distribution lines. Companies justify such ‘tamper proofing’ by arguing that this is essential to enforce the terms of their legal contracts with consumers and to meet the terms of a consumer warranty (the period under which they agree to cover any costs of failure, breakdown and repair).

In villages across Tanzania, Kenya and Uganda, these efforts to impose fiscal discipline on off-grid customers have created an arena of daily struggle over the terms of financial inclusion in energy markets. This is precisely the kind of ‘low-intensity battle’ that Antina von Schnitzler (2013) documented between on-grid consumers and energy utility companies in post-apartheid South Africa, where electricity payment meters, wires and transmission boxes emerged as the political terrain upon which residents of black townships sought to negotiate their rights and entitlements as citizens.

For some political scientists the question is: under what conditions might such struggles be articulated at a wider scale or result in public opposition to energy utility companies? Rather than speculate about the specific configuration of actors or processes that might see this unfold, however, we

30. Interview, off-grid solar executive, Nairobi, 20 February 2020.

31. WhatsApp communication, Betty Ndagire, Ugandan journalist, 16 March 2020.

share von Schnitzler's reluctance to assume that struggles with energy utilities in Africa must culminate in conventional forms of disagreement that are played out in a public political sphere. Tampering and non-payment by the customers of off-grid solar companies in East Africa — like on-grid customers in South Africa — demands to be understood as a political expression in its own right; it is, we propose, a form of corporate critique.

CONCLUSION: SOLAR POWER AFTER COVID-19

The ability of off-grid energy companies in East Africa to 'plug people into' the economy hinges on a countervailing dynamic of disconnection. Private physical infrastructures for solar power depend on the invisible financial, social and power relations which confer the ability, a dynamic which generates professional and popular critiques of corporate capital and private enterprise as channels of inclusion.

From diverse locations and subject positions, people are subjecting the companies they work for or buy from — and these relationships — to moral, political and economic scrutiny; they are examining the claims they make, the technologies they sell, their business practices and their ethics, and the prevailing wisdom that solar entrepreneurs in poor markets can both do good and do well. Alongside discourses of inclusion, these critiques address the mission-drift from popular inclusion to profitability, the mis-selling of solar home systems, and the technical limits of off-grid infrastructures for local income-generating activities. Closer attention to these distortions and disconnections shows the extent to which infrastructures of inclusion in the off-grid economy include people on a precarious rather than permanent basis.

Since 2020, the COVID-19 (SARS-CoV-2) pandemic has made these contradictions even more starkly apparent, creating new strains on off-grid energy systems and their inclusive claims. In the first half of 2020, sales of solar home systems in sub-Saharan Africa fell by 26 per cent (Gaventa, 2020). In March 2020, a survey of over 70 solar manufacturers, distributors and investors revealed that over half were unable to sustain their business for more than four months without approximately US\$ 3–10 million in relief loans or bridging funds (GOGLA, 2020a). Measures to prevent the spread of COVID-19 had a negative impact on market logistics, from the movement of salespeople to the movement of stock. The impact of the pandemic on already precarious rural livelihoods is calling into question the viability of off-grid markets, with investment commitments and cash flows severely impacted. In July 2020, a remote survey of customers for sub-Saharan Africa's largest off-grid companies reported that over one third (38 per cent) of rural customers were not confident that they would be able to make repayments in the next month (GOGLA, 2020a).

Faced with rising defaults and a liquidity crisis, off-grid solar companies confront the prospect of either repossessing equipment on a massive scale in the midst of a pandemic or being unable to attract further debt financing from international investors. Like many businesses around the world, off-grid solar companies sought urgent technical assistance to help them analyse their risks, looked for emergency funds to help cover operating costs and pay staff, and sought help lobbying governments across sub-Saharan Africa to recognize their sector as ‘essential’. Such efforts reveal a key paradox: private off-grid infrastructures of inclusion bypass the public grid but continue to call upon public funding. In so doing, they seek to establish an ‘essential’ public service without the constraints of public accountability.

Against this backdrop, the very real prospect that off-grid solar companies might lock low-income customers out or embark on a spate of repossessions led GOGLA, the global association for the off-grid solar energy industry, to issue a stern warning to members, reminding them that such actions risked the credibility and integrity of the entire sector. In its ‘Guidance to Members during the Pandemic’, GOGLA (2020b: 1, 3) writes:

It is important to recognize that low-income consumers in off-grid communities are particularly vulnerable to the potential impact of COVID-19. Clearly, strategic planning and swift action is needed (i) to protect our consumers and communities, (ii) for the health and safety of our employees, and (iii) [sic] the long-term security of our companies and the industry as a whole A product lock-out for a PAYGo consumer at this time would be a double blow — the loss of radio, TV or mobile phone to stay informed, or the loss of light whilst ill could be devastating.

Such statements indicate how discourses of inclusion not only obscure processes of adverse incorporation and exclusion but can also serve as leverage for private corporations to make public claims. The social and environmental credentials of off-grid solar companies in East Africa can sometimes appear to have shielded them from public scrutiny. Yet, the growth of the region’s off-grid economy has been subject to considerable critical commentary on the ground, from impact idealists, employees of solar companies and their consumers, who express growing unease with the adverse terms of inclusion, and outright expulsion, of the poor in off-grid markets. In this article, we have sought to make the discontent of actors in very different structural positions visible, seeking to grant their critiques recognition and legitimacy as a social and political practice, and to consider the varied authority or efficacy of these critiques. Appreciating how everyday critiques are articulated, managed and absorbed is important to understanding the fault lines and emerging politics of inclusive infrastructures, and to raising questions about how and to what extent private critiques translate into public accountability.

What is the likely impact of these critiques on the continued uptake or acceptance of solar technology in East Africa? Some readers and market analysts may argue that discontent with off-grid solar companies will have little economic force unless it significantly changes market demand. The

continued high cost of electrical grid extensions to remote locations, coupled with the nature of dispersed energy demand in rural areas, it might be argued, will render off-grid solar energy providers an important part of Africa's energy futures, regardless of the terms and conditions of inclusion. As this article highlights, however, the quest for market share and private profit has reshaped the off-grid solar industry, generating discontent, sustained critiques and forms of everyday resistance to its restructured connections and the forms of inclusion that it offers. Scrutiny of the contradictions embedded in these off-grid infrastructures raises searching questions about how governments, scholars, employees and customers will reshape the post-pandemic power of off-grid solar companies in Africa as they look to 'build back better'.

REFERENCES

- Acker, R.H. and D.M. Kammen (1996) 'The Quiet (Energy) Revolution: Analysing the Dissemination of Photovoltaic Power Systems in Kenya', *Energy Policy* 24(1): 81–111.
- African Energy* (2019) 'Mobisol and Solarkiosk Insolvencies Highlight Risk in Off-grid', *African Energy* 31 May. www.africa-energy.com/article/mobisol-and-solarkiosk-insolvencies-highlight-risk-grid
- Alliance for Rural Electrification (2019) 'High Profile Bankruptcies in the Off-grid Sector: Where Do We Go from Here?'. Brussels: Alliance for Rural Electrification. www.ruralelec.org/news-from-are/high-profile-bankruptcies-grid-sector-where-do-we-go-here
- Anderson, S. (2019) 'Why Are Investors Surging in Off-grid Energy?', *Next Billion* 14 May. <https://nextbillion.net/investments-off-grid-energy/>
- Bakke, G. (2016) *The Grid: The Fraying Wires between Americans and our Energy Future*. New York: Bloomsbury Publishing.
- Boamah, F. (2020a) 'Desirable or Debatable? Putting Africa's Decentralised Solar Energy Futures in Context', *Energy Research & Social Science* 62: 101390.
- Boamah, F. (2020b) 'Emerging Low-carbon Energy Landscapes and Energy Innovation Dilemmas in the Kenyan Periphery', *Annals of the American Association of Geographers* 110(1): 145–65.
- Boyer, D. (2014) 'Energopower: An Introduction', *Anthropological Quarterly*, pp. 309–33.
- Burger, A. (2019) 'The Solar and Renewables-fuelled Utility of the Future May Be Evolving in Sub-Saharan Africa', *Solar Magazine* 26 March. <https://solarmagazine.com/the-solar-and-renewables-fueled-utility-of-the-future-may-be-evolving-in-sub-saharan-africa/> (accessed 12 May 2019).
- Chatterjee, S. (2016) 'Articulating Globalization: Exploring the Bottom of the Pyramid (BOP) Terrain', *Organization Studies* 37(5): 635–53.
- Cholez, C. and P. Trompette (2019) 'Designing Infrastructure for the Poor: Transactions within Unstable Ecologies', in M. Kornberger et al. (eds) *Thinking Infrastructures*, pp. 335–54. Bingley: Emerald Publishing Limited.
- Cross, J. (2013) 'The 100th Object: Solar Lighting Technology and Humanitarian Good', *Journal of Material Culture* 18(4): 367–87.
- Cross, J. (2016) 'Off the Grid: Infrastructure and Energy beyond the Mains', in P. Harvey, C.B. Jensen and A. Morita (eds) *Infrastructures and Social Complexity: A Companion*, pp. 186–96. London: Routledge.
- Cross, J. (2019a) 'The Solar Good: Energy Ethics in Poor Markets', *Journal of the Royal Anthropological Institute* 25(S1): 47–66.
- Cross, J. (2019b) 'Selling with Prejudice: Social Enterprise and Caste at the Bottom of the Pyramid in India', *Ethnos* 84(3): 458–79.

- Cross, J. (2019c) 'No Current: Electricity and Disconnection in Rural India', in S. Abram, B.R. Winthereik and T. Yarrow (eds) *Electrifying Anthropology: Exploring Electrical Practices and Infrastructures*, pp. 65–82. London and New York: Bloomsbury Academic.
- Cross, J. (2020) 'Capturing Crisis: Solar Power and Humanitarian Energy Markets in Africa', *Cambridge Journal of Anthropology* 38(2): 105–24.
- Cross, J. and D. Murray (2018) 'The Afterlives of Solar Power: Waste and Repair Off the Grid in Kenya', *Energy Research & Social Science* 44: 100–09.
- Degani, M. (2017) 'Modal Reasoning in Dar es Salaam's Power Network', *American Ethnologist* 44(2): 300–14.
- Degani, M., B. Chalfin and J. Cross (2020) 'Introduction Fuelling Capture: Africa's Energy Frontiers', *Cambridge Journal of Anthropology* 38(2): 1–18.
- Dizard, J. (2019) 'Mobisol: A Cautionary Tale for Impact Investors', *Financial Times* 8 May. www.sun-connect-news.org/fileadmin/DATEIEN/Dateien/New/a_cautionary_tale_for_impact_investors_Financial_Times.pdf
- Dolan, C. and D. Rajak (2016) 'Remaking Africa's Informal Economies: Youth, Entrepreneurship and the Promise of Inclusion at the Bottom of the Pyramid', *The Journal of Development Studies* 52(4): 514–29.
- Donovan, K.P. and E. Park (2019) 'Perpetual Debt in the Silicon Savannah', *Boston Review* 20 September. <http://bostonreview.net/class-inequality-global-justice/kevin-p-donovan-emma-park-perpetual-debt-silicon-savannah>
- Elyachar, J. (2005) *Markets of Dispossession: NGOs, Economic Development, and the State in Cairo*. Durham, NC: Duke University Press.
- Fischer, A.M. (2018) *Poverty as Ideology: Rescuing Social Justice from Global Development Agendas*. London: Zed Books.
- Furukawa, C. (2014) 'Do Solar Lamps Help Children Study? Contrary Evidence from a Pilot Study in Uganda', *The Journal of Development Studies* 50(2): 319–41.
- Gaventa, J. (2020) 'The Rise and Fall and Second Coming of Off Grid Solar', *Energy Monitor* 23 November. <https://energymonitor.ai/technology/networks-grids/the-rise-and-fall-and-second-coming-of-off-grid-solar>
- Gleeson-White, J. (2015) *Six Capitals, or Can Accountants Save the Planet? Rethinking Capitalism for the Twenty-first Century*. New York: W.W. Norton & Company.
- GOGLA (2018) 'Global Off-grid Solar Market Report: Semi-Annual Sales and Impact Data'. Amsterdam: Global Off-grid Solar Energy Industry Association. www.gogla.org/global-off-grid-solar-market-report
- GOGLA (2020a) 'Consumer Insights during COVID-19'. Amsterdam: Global Off-grid Solar Energy Industry Association. www.gogla.org/sites/default/files/documenten/cp_consumer_insights_webinar2_9july2020.pdf
- GOGLA (2020b) 'Guidance to Members during the COVID-19 Pandemic'. Amsterdam: Global Off-grid Solar Energy Industry Association. www.gogla.org/sites/default/files/resource_docs/guidance_to_members_during_the_covid-19_pandemic.pdf
- Goldstein, J. (2018) *Planetary Improvement: Cleantech Entrepreneurship and the Contradictions of Green Capitalism*. Cambridge, MA: MIT Press.
- Hansen, U.E., I. Nygaard and M. Dal Maso (2021) 'The Dark Side of the Sun: Solar E-Waste and Environmental Upgrading in the Off-grid Solar PV Value Chain', *Industry and Innovation* 28(1): 58–78.
- Hickey, S. and A. Du Toit (2013) 'Adverse Incorporation, Social Exclusion, and Chronic Poverty', in A. Shepherd and J. Brunt (eds) *Chronic Poverty: Concepts, Causes and Policy*, pp. 134–59. Basingstoke: Palgrave Macmillan.
- IEA (2020) 'The Covid-19 Crisis is Reversing Progress on Energy Access in Africa'. Paris: IEA. www.iea.org/articles/the-covid-19-crisis-is-reversing-progress-on-energy-access-in-africa
- Jacobson, A. (2007) 'Connective Power: Solar Electrification and Social Change in Kenya', *World Development* 35(1): 144–62.

- James, D. (2014) *Money from Nothing: Indebtedness and Aspiration in South Africa*. Stanford, CA: Stanford University Press.
- James, D. and D. Rajak (2014) 'Credit Apartheid, Migrants, Mines and Money', *African Studies* 73(3): 455–76.
- Jones, M.B. (2007) 'The Multiple Sources of Mission Drift', *Nonprofit and Voluntary Sector Quarterly* 36(2): 299–307.
- Kish, Z. and M. Fairbairn (2017) 'Investing for Profit, Investing for Impact: Moral Performances in Agricultural Investment Projects', *Environment and Planning A: Economy and Space* 50(3): 569–88.
- Kouton, J. (2021) 'The Impact of Renewable Energy Consumption on Inclusive Growth: Panel Data Analysis in 44 African Countries', *Economic Change and Restructuring* 54(1): 145–70.
- Kudo, Y., A.S. Shonchoy and K. Takahashi (2019) 'Short-term Impacts of Solar Lanterns on Child Health: Experimental Evidence from Bangladesh', *The Journal of Development Studies* 55(11): 2329–46.
- Kumar, A. and B. Turner (2020) 'Sociomaterial Solar Waste: Afterlives and Lives After of Small Solar', in G. Bombaerts, K. Jenkins, Y. Sanusi, Wang Guoyu (eds) *Energy Justice across Borders*, pp. 155–73. Berlin: Springer.
- Kumar, A. et al. (2019) 'Solar Energy for All? Understanding the Successes and Shortfalls through a Critical Comparative Assessment of Bangladesh, Brazil, India, Mozambique, Sri Lanka and South Africa', *Energy Research & Social Science* 48: 166–76.
- Lewis, D. (2019) 'Social Entrepreneurship before Neoliberalism? The Life and Work of Akhtar Hameed Khan'. Social Policy Working Paper Series No. 02–19. London: Department of Social Policy, London School of Economics and Political Science.
- Loloum, T., S. Abram and N. Ortar (2021) 'Introduction: Politicizing Energy Anthropology', in T. Loloum, S. Abram and N. Ortar (eds) *Ethnographies of Power: A Political Anthropology of Energy*, pp. 1–24. London: Berghahn Books.
- Maurer, B. (2015) *How Would You Like to Pay? How Technology Is Changing the Future of Money*. Durham, NC: Duke University Press.
- Meagher, K. and I. Lindell (2013) 'ASR Forum Engaging with African Informal Economies: Social Inclusion or Adverse Incorporation?', *African Studies Review* 56(3): 57.
- Miller, D. (2010) *Selling Solar: The Diffusion of Renewable Energy in Emerging Markets*. London: Routledge.
- Ndagire, B. (2020) 'Sales Agent Remanded for Modifying Solar Panels', *The Daily Monitor* 11 February. <https://energycentral.com/news/sales-agent-remanded-modifying-solar-panels>
- Neichin, G., D. Isenberg and M. Roach (2017) 'Next Billion's Most Influential Post of 2017: An Impact Investor Urges Caution on the "Energy Access Hype Cycle"', *Next Billion* 22 December. <https://nextbillion.net/an-impact-investor-urges-caution-on-the-energy-access-hype-cycle/> (accessed 3 June 2021).
- Neumark, T. (2017) "'A Good Neighbour Is Not One that Gives": Detachment, Ethics, and the Relational Self in Kenya', *Journal of the Royal Anthropological Institute* 23(4): 748–64.
- Neumark, T. (2020) 'Trusting the Poor: Unconditional Grants and the Caring Bureaucrat in a Kenyan Slum', *Anthropological Quarterly* 93(2): 119–49.
- Ockwell, D. and R. Byrne (2016) *Sustainable Energy for All: Innovation, Technology and Pro-poor Green Transformations*. London: Routledge.
- Ojong, N. (2021) 'The Rise of Solar Home Systems in Sub-Saharan Africa: Examining Gender, Class, and Sustainability', *Energy Research & Social Science*. <https://doi.org/10.1016/j.erss.2021.102011>
- Pombo-van Zyl, N. (2019) 'Mobisol Insolvency: Is this the End to Private Electrification Projects?' *ESI Africa* 29 April. www.esi-africa.com/industry-sectors/renewable-energy/mobisol-insolvency-is-this-the-end-to-private-electrification-projects/
- Prahalad, C.K. (2006) *The Fortune at the Bottom of the Pyramid*. Philadelphia, PA: Wharton School Publishing.

- Rodima-Taylor, D. and E. Bähre (2014) 'Introduction: Mutual Help in an Era of Uncertainty', *Africa: The Journal of the International African Institute* 84(4): 507–09.
- Roy, A. (2010) *Poverty Capital: Microfinance and the Making of Development*. Berkeley, CA: University of California Press.
- Samarakoon, S., A. Bartlett and P. Munro (2021) 'Somewhat Original: Energy Ethics in Malawi's Off-grid Solar Market', *Environmental Sociology*. <https://doi.org/10.1080/23251042.2021.1893428>
- Sanyal, S., C. Chen and M. Caldwell (2019) 'The Impact Investors' Blind Spot: Local Clean Energy Entrepreneurs in Kenya'. World Resources Institute Working Paper. The Hague: World Resources Institute.
- von Schnitzler, A. (2008) 'Citizenship Prepaid: Water, Calculability, and Techno-politics in South Africa', *Journal of Southern African Studies* 34(4): 899–917.
- von Schnitzler, A. (2013) 'Traveling Technologies: Infrastructure, Ethical Regimes, and the Materiality of Politics in South Africa', *Cultural Anthropology* 28(4): 670–93.
- Schwittay, A.F. (2011) 'The Financial Inclusion Assemblage: Subjects, Technics, Rationalities', *Critique of Anthropology* 31(4): 381–401.
- Sharma, J. (2017) 'Avoiding the Neoliberal Trap in Social Entrepreneurship', *Stanford Social Innovation Review* 18 October. https://ssir.org/articles/entry/avoiding_the_neoliberal_trap_in_social_entrepreneurship
- Sheya, M.S. and J.S. Mushi (2000) 'The State of Renewable Energy Harnessing in Tanzania', *Applied Energy* 65(1): 257–71.
- Szeman, I. (2015) 'Entrepreneurship as the New Common Sense', *South Atlantic Quarterly* 114(3): 471–90.
- Waldron, D. and A.M. Swinderen (2018) 'Remote Lockouts: The Dark Side of Pay-as-you-go Solar?', *CGAP blog* 9 May. www.cgap.org/blog/remote-lockouts-dark-side-pay-you-go-solar
- Winther, T. (2008) *The Impact of Electricity: Development, Desires and Dilemmas*. Oxford: Berghahn Books.
- World Bank (2018) 'Off-grid Solar Market Trends Report 2018'. Washington, DC: World Bank.
- Wood Mackenzie (2019) 'Strategic Investments in Off-grid Energy Access: Scaling the Utility of the Future at the Last Mile'. Power & Renewables Research Report in partnership with Energy 4 Impact. Boston, MA: Wood Mackenzie.
- Zollmann, J., D. Waldron, A. Sotiriou and A. Gachoka (2017) 'Escaping Darkness: Understanding Consumer Value in PAYGo Solar'. Washington, DC: Consultative Group to Assist the Poor. www.cgap.org/research/publication/escaping-darkness-understanding-consumer-value-paygo-solar

Jamie Cross (corresponding author; jamie.cross@ed.ac.uk) is Professor of Social and Economic Anthropology at the University of Edinburgh, Scotland. His writing on the social and material politics of off-grid solar energy in places of chronic poverty has been published in *Ethnos*, *The Guardian*, *Journal of the Royal Anthropological Association*, *Limn* and *South Atlantic Quarterly*.

Tom Neumark (thomas.neumark@sum.uio.no) is a Postdoctoral Fellow at the Centre for Development and the Environment and the Institute of Health and Society at the University of Oslo, Norway. He is a social anthropologist who has been carrying out research in East Africa since 2004 on issues of technology, health and welfare.