



Contents lists available at ScienceDirect

World Development

journal homepage: www.elsevier.com/locate/worlddev

The prepaid electric meter: Rights, relationships and reification in Unga, Tanzania

Veronica Jacome*, Isha Ray

University of California, Berkeley, United States



ARTICLE INFO

Article history:

Accepted 16 January 2018

Available online 6 February 2018

Keywords:

Sustainable Development Goal 7

Access to electricity

Commodification

Cost-recovery

Culture of non-payment

ABSTRACT

Sustainable Development Goal 7, with the light bulb and power button as its symbols, in effect promotes the universal right to basic electricity services. Access for all demands both affordability and cost-recovery, and utilities (and donors) increasingly require users to shoulder the greater burden of cost-recovery. We argue that the electricity system is underpinned by a set of relationships among user, provider and the service itself: these relationships are mediated by the meter, the technology of commodification. Using a constant-comparison approach, and based on a year of interviews and document analysis, we compare postpaid and prepaid meter regimes in Unga, Tanzania. We ask: what difference does the mode of payment make to the (residential) user, the utility, and to the prospects for meeting SDG 7? We find that the prepaid meter becomes reified with its automated monitoring and measurement mechanism, rendering the once-familiar meter reader obsolete, and shutting off the flow of electricity as soon as the customer's "units" have run down. Reification makes the utility more invisible to the customer, who now blames the meter rather than the utility for poor service or high bills. Our interviews reveal broad support for the prepaid meter, however, because economically vulnerable users expressed greater fear of debt than of the dark, and were willing to cede control of their consumption to the new meter. These findings undermine the common accusation of a "culture of nonpayment" in Africa. We also find that prepaid meters may incentivize the partial return to biomass-based fuels when cash is not available – exactly the behavior that universal access to electricity is supposed to prevent. We conclude that, if access to electricity in sub-Saharan Africa becomes entirely contingent on payment prior to use, this is not fully compatible with a commitment to universal basic access.

© 2018 Elsevier Ltd. All rights reserved.

1. Introduction: Electricity as a right and a commodity

Sustainable Development Goal 7 (or SDG 7) – the United Nations initiative to “ensure access to affordable, reliable, sustainable and modern energy for all” – rests on the link between access to clean energy services and improved living conditions for the poor (United Nations, 2015). Researchers on energy policy and advocates for the rural and urban poor have strongly argued that access to affordable and clean energy is essential for the alleviation of deep poverty and poor health in the developing world (e.g. Smith, 2002; Sagar, 2005). In the quest to decrease the reliance on polluting fuels for cooking, heating, and lighting in low-income communities, SDG 7, with the light bulb and power button as its symbols, in effect promotes the universal right to basic elec-

tricity services. While such a right has no formal recognition, universal electricity access is now widely seen as a proxy for social and economic rights (Tully, 2006).

Many non-governmental initiatives, as well as foreign aid and foreign direct investment efforts, are devoted to electrification projects. Prominent examples include calls for universal access to electricity by the United Kingdom and the United States through their Power for All (UK) and Power Africa (USA) campaigns. Sub-Saharan African government initiatives include Ghana's Universal Electrification Plan and Ethiopia's Universal Electricity Access Program; their efforts reinforce the recognition of electricity as a necessity in the modern world.¹ These initiatives include the construction of electricity infrastructure, the distribution of new technologies within existing systems, and the reconfiguration of utility practices through new policies.

* Corresponding author at: 310 Barrows Hall University of California, Berkeley, CA 94720-3050, United States.

E-mail addresses: v.jacome@berkeley.edu (V. Jacome), isharay@berkeley.edu (I. Ray).

¹ See: <https://www.gov.uk/government/news/britain-and-us-unite-to-power-up-africa>. Also Bayissa (2008) and Kemausuor and Ackom, 2017 for programs in Ghana and Ethiopia, respectively.

Providing electricity services, especially universal basic services, entails significant capital, operations and maintenance, and ongoing delivery costs. Since these costs must be paid for, it is either up to the taxpayers (i.e. through direct or indirect taxes that go into government revenues) or up to the service users (i.e. through various fees) to pay for them (Harris, 2003, p 15). Even if the upfront or operational costs are financed by an international loan or by private investment capital, eventually these sources must be repaid either via taxation or via user fees. Who pays – taxpayers in general or specific consumers – ultimately dictates the nature and extent of electricity access for individual households. Access for all demands cost-recovery to maintain and extend services, and affordability to be ‘for all’, at the same time. Therefore, a tension surrounds the discourse on the implementation of SDG 7. Human rights goals and their advocates are more concerned with who has, and who does not have, access to basic electricity services than with who pays for what. Cost-recovery goals and their advocates are also concerned with access, but argue that it is neither practical nor productive to expect costs to be borne entirely, or even mainly, by the state. The terms of commodification – or, who pays, how they pay and how much they pay – are thus intimately connected to the ways in which either goal can be met. Two questions follow: Should the taxpayer or the user pay, and in what proportions? Second, if the user pays, should payments be made before the service is made available or after? This paper is concerned with the implications of the second question.

Radical changes in payment regimes are taking place in Sub-Saharan Africa (SSA). Partly a reaction to perceived flaws within utilities’ cost-recovery techniques (discussed below), utilities in SSA are moving away from a postpaid electricity system – one in which users pay after a period of use – to a prepaid system in which users must pay prior to use. A report by the NorthEast Group, a smart technology and infrastructure consulting firm based in Washington, DC, projects a 234% growth in the market value of prepaid electricity meters for SSA by 2034 (Northeast Group, 2014). This report has helped to redefine the status quo in metering technologies, with academics, other consulting firms, and online news outlets citing it heavily.² The Zanzibar Electricity Corporation (ZECO) is one such SSA utility switching over to prepaid services as the preferred mode for their customers.

The roles and responsibilities of user and provider are different in each payment regime. The change in metering technology disconnects users instantaneously when their “units” run down; unlike the postpaid system, prepaid meters in SSA do not need a meter reader or utility employee to measure consumption or disconnect users. Thus, as we shall argue, prepaid systems are set to alter the human engagements previously established through the traditional postpaid system, i.e., the relationships between user and provider, the meter, and the electricity service itself.

Recognizing that the mode of payment for electricity is but one entry point into the social relations embedded in technologies, we explore the following questions:

- (i) Given that prepaid and postpaid meters both commodify electricity services, what difference do the terms of commodification (i.e. how and when users pay) make to low-income communities and to the utility?
- (ii) If access to electricity embodies a set of implicit and explicit social relations what difference do the terms of commodification make to these relationships?

We use the findings from these questions to discuss our final, broader question:

- (iii) Affordable and clean energy *for all* is the seventh Sustainable Development Goal. How do the terms of commodification affect whether, and how, SDG 7 may be met?

This is the first paper (that we are aware of) to critically compare the perspectives of both postpaid and prepaid users in a single region transitioning from one metering regime to the other. As prepaid becomes the preferred meter in SSA, we examine the changing relationships embedded within each payment system. In line with previous research, we find that the prepaid meter disciplines users to use no more than what they can afford (van Heusden, 2012; Jaglin & Dubresson, 2016),³ and has the support of the utility in large part because it reduces its nonpayment problem (Plancq-Tournadre, 2004). We find that many customers prefer the prepaid meter; it controls them (as they see it) through its automatic disconnection mechanism, but this control helps them to control their finances (Ghanadan, 2012, p 417; Baptista, 2015). The change from postpaid to prepaid therefore relieves vulnerable consumers of debt, but that relief comes with the fear of being left in the dark. The smallest consumers in our study, in fact, preferred postpaid meters. We also find that the prepaid meter tends to become reified in these low-income communities, often being conflated with the service provider in common discourse, and implicitly providing the utility with a certain distance from customer dissatisfaction. Electricity problems that were once blamed on a “cheating” ZECO staff, or on an incompetent meter reader, now tend to be attributed to the *mita mpya* (the new meter) itself.

When a basic level of electricity access is considered akin to a right, is one of a handful of globally agreed-upon development goals, and offers the possibility of improved living conditions for the poor, we must critically assess the nature of the security(ies) on offer when prepaid metering replaces postpaid. In our case study of Unguja, Tanzania (where ZECO operates), we argue that financial insecurity for many hitherto postpaid consumers has been replaced by insecurity of access to the electricity service itself. For most of these consumers, financial insecurity was the greater stressor; nevertheless, with automatic disconnection but without a low-priced (or free) lifeline entitlement, the lowest-income households are at risk of falling through the cracks of SDG 7. The utility is more secure with the prepaid meter, because customers can no longer rack up unpaid bills. However, we find that the discourse of controlling debt and using “only what you can afford”, with which prepaid meters are promoted, applies largely to the residential and micro-business sectors. Many (though not all) government entities that are in heavy debt to the utility and large private sector customers continue on the postpaid system, while the public face of ZECO’s debt remains the lay citizen.

2. The electric meter and the terms of commodification

The terms of commodification for basic public services determine the universal or otherwise nature of access to, and use of, such services. The debate on who should pay for electricity has brought to the forefront the difficulties of commodifying it without excluding individuals from the benefits it brings.

Whether payment should come from general revenues or individual users, and how the costs should be divided, is a debate that centers around fairness, affordability, and efficiency.⁴ In principle, state-subsidized electricity provides affordable access for the poor,

² See, for example: Baptista (2015), Jack and Smith (2016), Sahel Standards News (2016).

³ Similar point wrt water meters, von Schnitzler (2008).

⁴ See Williams and Ghanadan (2006) and Estache (2008).

yet for the poor to benefit from subsidized electricity rates, they need a connection. Not everyone can afford the often steep upfront cost of a connection (Winkler et al., 2011). Furthermore, because electricity consumption and income are not always correlated, consumption-based subsidies – a common strategy – often benefit medium- and high-income households rather than those most in need (Auriol & Blanc, 2009; del Granado, Coady, & Gillingham, 2012). Thus, opponents of state subsidies see them as economically inefficient and socially inequitable, and advocate for their reduction. At least a dozen SSA states have taken steps towards this end; many continue to subsidize (Alleyn & Hussain, 2013; Kojima, Bacon, & Trimble, 2014), but with an increasing emphasis on the user as the locus of cost-recovery. This partial shift from a general cost-recovery strategy towards a user-centric one is taking place in several service sectors beyond electricity.

Where taxpayer-subsidized electricity rates remain important, providers look to make optimal use of existing resources by minimizing service inefficiencies (Wamukonya, 2003; Eberhard et al., 2008). One regularly targeted source of inefficiency is nonpayment; the user fails to pay his or her electricity bills, resulting in what utilities call “arrears” if they remain unpaid. Nonpayment of utility bills is common in SSA and beyond. Bill payment losses to a utility are measured by calculating total cash collected in each year as a proportion of total revenue billed in the same year. A 2016 World Bank report claims that bill payment losses, which include nonpayment, range from roughly two percent in nine SSA countries to above 25 percent in six (Trimble, Kojima, Perez Arroyo, & Mohammadzadeh, 2016).⁵

The literature suggests two causes of nonpayment: users' inability to pay (Fankhauser & Tepic, 2007; Lampietti, Banerjee, & Branczik, 2007), and a “culture” of nonpayment. Two separate reports published by the World Bank suggest that the lack of a strong payment culture leads to customers refusing to pay their bills (Briceño-Garmendia & Shkaratan, 2011, p 100; Rosnes & Shkaratan, 2011, p 122). Prominent economists have argued that “no one wants to pay for it” when electricity is seen as a right and not a private good (e.g. *The Economist*, February 27, 2016). Alternatively, critical theorists argue that nonpayment is a form of “the quiet encroachment of the ordinary” (Bayat, 2004), or a counter politics of citizens simply unable to afford the essentials of modern urban life. Some researchers suggest that the incapacity to pay is much more the norm than the (alleged) payment-resistant “culture” among Africa's urban poor (e.g. Plancq-Tournadre, 2004). Other reports reveal that a large portion of unpaid bills belong to government institutions and larger, non-residential users (Wamukonya, 2003; Trimble et al., 2016). Discussions around nonpayment and efficiency, however, usually revolve around the average residential user. Current strategies to counter nonpayment are also geared towards the domestic customer, such as the expansion of metering and consumption-based payment (Keelson, Boateng, & Ghansah, 2005; Trimble et al., 2016). While postpaid meters remain the norm, prepaid services are growing in SSA in part because utilities and policy makers see their instant disconnection feature as a more reliable route to cost-recovery (Bayliss & McKinley, 2007).

In the postpaid system payment is made after a period of consumption, for example, at the end of a monthly cycle. While users consume units (kilowatt-hour or kWh), the postpaid meter measures and displays accumulated consumption. Generally, a meter reader reads the number displayed by the meter and subtracts the current reading from the previous one to tally consumption

for a billing period.⁶ To pay, customers can go online, or mail a check, or travel to billing offices, depending on how a specific system is set up. Failure to pay results in arrears (i.e., accumulated unpaid bills), and the disciplining of nonpayment occurs through fines and the possibility of eventual disconnection. This is an unreliable system from the utility's perspective, because the postpaid system is a credit risk, enabling nonpayment. Reports also suggest that, for utilities, postpaid systems encourage “poor payment discipline” as they allow for collusion between the meter reader and the user (Halpern, Kenny, & Dickson, 2008; Kojima et al., 2014, p 4). Prepaid meters are designed to block the flow of electricity unless payments have been made; they were initially introduced into South African townships as a reliable system for a population that was considered unreliable and not creditworthy (Jaglin & Dubresson, 2016). In prepaid systems, users pay prior to consuming. If electricity costs 10 cents per kWh, a customer purchasing 5 USD worth of kWh would receive approximately 100 kWh; kWh can be bought from utility offices, or third-party vendors, and in some regions, remote payment is possible with cellphones. The meter counts down as the units are consumed. Once 100 kWh are used up it disconnects the supply, automatically cutting off users who have not “topped up” (i.e., pre-purchased additional kWh).

Baptista (2015) nicely summarizes the range of critiques of prepaid systems, which have been called a proxy for neoliberalism, a disciplining technique over citizens, and a political tool. Linking broad neoliberal policies with prepaid metering, Ruiters (2007) sees these meters as a form of responsabilization, or, the supplanting of traditionally government responsibilities by new demands made on the individual (also van Heusden, 2012; von Schnitzler, 2013). Critics argue that by promoting this shift under the guise of universal access, and crediting the new regime for enabling usage within one's means, the utility tasks the meter with a dual agenda. On the one hand, it relieves the utility's debt concerns, while on the other hand it implies that universal access is achievable as long as users can afford it. Earlier work on the UK experience also critiqued prepaid meters for “effectively [hiding] or [disguising] the issue of low levels of access” (Graham and Marvin, 2001, p 299). Following this critique, Gupta (2015) sees the use of prepaid meters by the poor as a paradoxical situation in which access exists but electricity may not. Many scholars view these meters as tools of control over low-income users, arguing that the change from the risk of debt to that of disconnection jeopardizes the rights of poor people (van Heusden, 2012), or that when money is unavailable residents may go “stretches of time without lights or clean water” (Miraftab and Wills, 2005, p 203). Survey results from Ghana show that low-income prepaid users worry about disconnections (Quayson-Dadzie, 2012; Miyogo, Nyambamba, & Nyangweso, 2013); survey results from Zambia and South Africa also indicate that constant rationing may lead to the increased use of charcoal and wood for cooking (Malama, Mudenda, Ng'ombe, Makashini, & Abandaet, 2014), and to “self-disconnection” by cutting out “superfluous” tasks such as heating and ironing (Plancq-Tournadre, 2004, p 22).

Prepaid meters clearly have advantages, critiques notwithstanding. From the perspective of consumers, the prepaid meter offers increased control over consumption, payment and debt. After surveying prepaid customers in SSA, four studies conclude that the meter provides users with budgeting support, reductions in consumption through (self)-rationing, and increased awareness

⁵ Utilities also deal with other technical and non-technical losses, such as electricity theft through illegal connections, meter tampering, and breakages (see Winther (2012)). Therefore, bill payment losses are only part of a utility's loss portfolio.

⁶ The use of a meter reader is common in SSA, while in other parts of the world postpaid systems do not always require them; reading can be done remotely, and at varying intervals, depending on their technical capacity. These specific meters are called “smart meters” or automatic meter reading devices. In addition to reading usage, many also offer two-way or one-way communication between the provider and user, real-time electricity use data or even emissions information.

of consumption (Tewari & Shah, 2003; Miyogo et al., 2013; Malama et al., 2014; Mburu & Sathyamoorthi, 2014). Baptista (2015) finds prepaid users in Maputo to be largely satisfied with their control over budgeting and consumption; given the tenuous economics of the urban margin, she credits the prepaid meter with enabling residents to pursue at least some modern comforts. Differentiated services, and differentiated modes of paying for services, contrary to traditional arguments against “splintering” the urban population, may actually narrow rather than accentuate access gaps by providing new opportunities for access (Jaglin, 2008; cf Graham & Marvin, 2001).

From the perspective of the utility, the prepaid meter reduces inefficiencies through streamlining bill delivery as well as bill collection, and by rendering continued nonpayment obsolete. It serves as a “technological upgrade” by virtue of replacing the old technology. Although prepaid meters cost more than postpaid upfront, they reduce non-revenue usage and the cost of bill collection services (Ontomwa, 2014; Kojima & Trimble, 2016). The World Bank has approved funding for prepaid installations in several Sub-Saharan African countries, citing both these aspects as the benefits of their loans (World Bank Group, 2003b, 2003a; World Bank Group, 2016a, 2016b). Furthermore, utilities faced with electricity theft worry that users can tamper more easily with postpaid meters (Tewari & Shah, 2003; Mwaura, 2012) and so welcome their replacement.⁷

Metered consumption, whether prepaid or postpaid, commodifies electricity services. The implicit assumption behind both sides of the payment-timing debate is that the switch from one mode of commodification (postpaid) to the other (prepaid) changes the relationships between the consumer, the provider, and the electricity service itself. To understand the intersection of commodification and its attendant social relationships, we turn to the concept of reification.

Reification (literally, “thingification”) is said to occur when individuals engage with others through the process of commodifying goods and services (Marx, 1867). Social relationships between people subsequently become expressed by and through the commodified object. Lukács (1971) argued that reification makes the commodity or object seem to be actively determining actions and relations; when this phenomenon becomes normalized, market exchange is no longer seen as one particular form of interaction among many, but as a “natural form of social interaction” (Jütten, 2010, p 237, emphasis added). The increasing presence of technologies embedded within the commodification process heightens this condition (Feenberg, 2002). Technological mediations further fragment human-to-human engagements, and can themselves become reified such that “man-produced things” appear to become “independent of man . . . and govern his life” (Petrović, 1983, p 411).

In *The Reification and Dictatorship of the Water Meter*, Loftus (2006) shows that water services in Durban, South Africa are commodified through mechanized monitoring and measuring by the water meter; in this process the meter appears to gain people-like qualities. Loftus argues that the water meter attains a governing power over everyday rhythms, imposing itself on prior habits. By analogy, the electric meter can also impose itself on prior patterns of electricity use. Our research in Unguja finds that the prepaid electricity meter, in particular, becomes reified, at least in cash-constrained settings within SSA. Postpaid technology visibly relies on human intermediaries to measure and disconnect, setting it apart from prepaid technology, which consolidates the tasks of measuring and disconnecting within the device itself. This new

mode of access isolates the user from the utility by taking away the key intermediary, the meter reader. It takes away the visits to the utility offices to pay bills and the visits from the utility for bill delivery and collection. The technology itself seems to take on a governing role in the flow of electricity; the reliability of the prepaid regime rests on the technology, with its surveillance and disciplining mechanism, whereby “[disciplinary power] is exercised through its invisibility” (Foucault, 1977, p 187). Drawing on the concept of reification, we show that these changes bring about a technologically-induced reshaping of how customers view the utility, the meter, and the electricity service itself.

In this study, we compare the prepaid and postpaid meter through the experiences of low- to middle-income consumers in Unguja, Tanzania. We make explicit the nature of those changes through a comparison of the perceptions and practices of prepaid and postpaid users; we examine who controls what and how, who lends and who borrows from whom, and how the user-provider relationship is “seen” in both regimes. Thus far, the literature on modes of electricity (or water) commodification and the social relations embedded therein, has analyzed these changes mainly through a postpaid lens, without comparing these in detail to the impacts of paying through the postpaid meter. The postpaid regime has served as the benchmark for (paid) urban electricity because the majority of the world uses it, and prepaid therefore represents a change from what seems normal. Such normalization has allowed the deficiencies of postpaid meters relative to prepaid meters (and of prepaid relative to postpaid), from the users’ perspectives, to be underemphasized in studies of electricity access. Our research breaks from this tradition by drawing equally on experiences from postpaid and prepaid users in Unguja, where we look not only at what the meter does but also at how it is seen.

3. Electricity services and payment in Unguja, Tanzania

Unguja, Tanzania (Fig. 1a) is a semi-autonomous island off the coast of East Africa. According to a 2014 wage report, the median wage in Zanzibar⁸ was 125 USD per month (1 USD = 1,600 TSh in 2013); those who were self-employed earned on average 50 USD a month, and those on contracts earned 200 USD (Tijdens, Besamusca, & Kahyarara, 2014). ZECO, the only electricity provider in Unguja, provides services to approximately 53 percent of households,⁹ with per capita consumption in 2009 at approximately 106 kWh per year (Govt. of Zanzibar, 2011). Given this yearly consumption, an average five-person household would consume roughly 1.5 kWh per day, which is enough to power a few hours of TV, energy efficient lightbulbs for a small home, and a fan.

Citing the systemic problem of unpaid electricity bills as a major concern, ZECO is in the process of shifting payment regimes from a completely postpaid metering system to a prepaid one. The first prepaid meters were installed in early 2000 through a World Bank loan (World Bank Group, 2003a). As of 2014, domestic and small commercial customers using postpaid meters made up ~23% of all electricity used, while similarly-situated prepaid customers used ~40% (Govt. of Zanzibar, 2015, p 67).

The postpaid and prepaid systems in Unguja resemble the generalized structure laid out in the previous section. Postpaid customers typically travel to the main billing office in Stone Town (otherwise known as Zanzibar Town) to pay their bills, although

⁸ Zanzibar is an archipelago, which consists of two main islands – Unguja, the largest, and Pemba.

⁹ This estimate is from our own calculations, based on Tanzania’s National Bureau of Statistics April 2014 Report on the Basic Demographic and Socio-Economic Profile of Zanzibar, Tables 12.9 and 12.10 (https://tanzania.go.tz/egov_uploads/documents/TANZANIA_ZANZIBAR_SOCIO_ECONOMIC_PROFILE_sw.pdf). Previous work from specific sites in Unguja has reported lower coverage rates (e.g. Winther, 2012).

⁷ Various modes of electricity theft are common in our study site of Unguja (Winther, 2012). Replacing postpaid with prepaid technology has yet to produce significant reductions in theft, however: one study actually found an increase (Effah & Owusu, 2014).



Fig. 1. The Republic of Tanzania. (a) Mainland Tanzania and the Zanzibar archipelago Google Maps (2017). (b) The island of Unguja with sampling sites and regional divides. Zanzibar Town is located in the southwest region, or “Mjini Magharibi”.

ZECO staff visit villages far from the main office on a monthly basis to collect billed payments. Residents can choose to pay using this method, or travel the hour or so (one way) to Stone Town. For prepaid meters, the main office provides vouchers for kWh purchased, but many smaller stores around the island do the same – allowing customers to purchase top-up kWh closer to their homes.¹⁰ Disconnections with postpaid meters are supposed to occur when a user has arrears; there is no clear cutoff threshold, however, and many customers continue using electricity despite small arrears.

Poor tariff structure and mismanagement allegedly plague the Zanzibari electric utility, contributing substantially to its debt crisis. Overall, ZECO is said to owe TANESCO (the mainland Tanzanian utility) between 20 and 30 million USD, although the exact number is in dispute (Issa, 2014; Maulid, 2015). A mixture of subsidized electricity rates and lack of state funding creates a constant budget deficit. As of 2017, ZECO purchased electricity from TANESCO at a higher rate than what they charged customers (Mtulya, 2017). Government institution arrears, running into the millions, greatly exacerbate the debt crisis. According to ZECO sources, government institutions owe it ~12.8 million USD, whereas small businesses and domestic consumers owe 4.5 million USD (Maulid, 2015; Yussuf, 2015). ZECO also faced accusations of providing their management team and higher-level staff with free electricity and generous gifts, and of wrongly charging large commercial customer thousands of dollars not detailed in their electricity bills (The Guardian, 2013; Maulid, 2015).

The electricity system in Unguja is not singular. Similar problems, similar patterns, and similar policy shifts from postpaid to prepaid metering are occurring across SSA. Throughout the region, states are challenged with providing a service that is deemed necessary for modern living, and with maintaining the fine balance between recovering the cost of that service and serving their largely vulnerable populations. And throughout the region, the metering changes aimed at greater cost-recovery are directed mainly at small users rather than at large public or private institutions.

4. Data and methods

We incorporated three components to analyze the differences between the payment systems for the users and the

utility, and for the social relationships that underpin electricity services: semi-structured interviews with ZECO customers, key informant interviews with ZECO staff, and content analysis of available documents. Fieldwork took place over the course of three extended visits by the first author, from 2014 to 2016.

The first trip focused on preliminary observations of the electricity network and day-to-day workings of Zanzibari life. Daily observations helped in identifying areas with postpaid and prepaid meters, the location of the main utility office and regional payment centers, and the modes of transportation accessible to regions around the island. We established a working relationship with ZECO, and conducted our first twenty interviews with its customers. Interviews began with basic questions concerning monthly electricity consumption, and the billing and payment process. Many people spontaneously offered up their personal grievances or notes of satisfaction, through which the ways in which the utility and electricity were being seen and discussed started to emerge. We encouraged people to discuss their views on postpaid meters if they had switched to prepaid, or on prepaid if they had postpaid; these conversations revealed their preferred mode of access and why. To gain baseline perspectives on both systems we also interviewed three small business owners, chosen at random amongst those that sold electricity appliances and lighting fixtures. These interviews revealed user experiences as relayed by customers to the shopkeepers, and further informed our own user interviews.

The semi-structured interviews established the importance of embedded relationships within Unguja’s electricity system. While responding to questions about their monthly consumption and payments, users often discussed (without prompting) their interactions with, and reflections on, the meter and meter reader. We noted these and asked follow-up questions where possible. While responding to service provision questions, such as their level of satisfaction with their electricity connection, many respondents also divulged their views of ZECO as a service provider.

Over 2015 and 2016 we conducted an extensive set of interviews, incorporating insights from the initial 20, on the everyday practices of those using postpaid and prepaid meters, and on how their users saw ZECO and the access to electricity that ZECO provided. We broadly followed the constant comparison method (Glaser & Strauss, 1967; Corbin & Strauss, 1990), a method in which the final interview dataset and the theoretical

¹⁰ There are plans underway to have mobile device capabilities so customers can purchase top-ups via their cellphones. See: <http://www.thecitizen.co.tz/News/Business/1840414-3306120-2mrstzd/index.html>.

understanding of a social phenomenon are iteratively determined.¹¹ This resulted in 45 new semi-structured interviews of electricity users. Our interview protocol allowed for themes to emerge naturally with each new conversation, adding content and direction to the subsequent ones. This process continued until saturation, i.e., when user responses started to produce little variation. Over the course of seven months a total of 65 interviews were conducted, of which 51 were complete enough to be included in this study.

Participants chosen for the semi-structured interviews had different job statuses, included women and men, were postpaid and prepaid users, spanned age groups and family sizes, and were geographically dispersed (Fig. 1b). Unguja's urban center is Stone Town (Fig. 1b), and the majority of the population lives within its broader periphery (the Mjini Magharibi region). Stone Town also contains the main ZECO billing center. We approached many individuals while walking through different neighborhoods, chosen through observations as being poor or non-poor, urban or non-urban (noted by differences in habitation density and distance from markets), and having predominantly postpaid or prepaid meters (these were easily detected from the street). Neighborhoods were differentiated as poor or non-poor according to the quality of roads and household building materials (concrete, thatch, coral rock, wood, or tin). We relied on snowball sampling for difficult-to-access neighborhoods and for people in categories that remained underrepresented through our primary approach. Most participants welcomed the chance to be interviewed. The first author conducted all interviews in Swahili; the interviews lasted between 45 and 120 min.

Between trips and after the final field visit, we undertook content analysis of documents relevant to the broader socio-economic background of Unguja. We analyzed data from a 2012 population and housing census by the National Bureau of Statistics (NBS), Tanzania, and a 2013 study by the Oxford Poverty and Human Development Initiative (OPHI) (NBS, 2013; OPHI, 2013). OPHI establishes incidence of poverty using the following indicators: health, education, living standards ("cooking with fuel, sanitation, cooking water source, access to electricity, type of floor and ownership of assets") (NBS, 2013). These statistics show that ~51 percent of rural Zanzibaris lived below the poverty line in 2012, compared to 36 percent in urban areas; rural areas were also at greater distances from key facilities such as schools, markets, and hospitals (NBS, 2013, p 12).

To understand the perspective of the service provider, we relied first on document analysis, including the Zanzibari government's online database on government meetings and ZECO-related articles from local and regional newspapers. These helped us to gather information on current policies and their evolution, and informed our open-ended key informant interviews with utility staff members. The interviews lasted between one and three hours each. Our questions focused on cost-recovery efforts by the utility, the major hurdles facing their efforts to decrease debt, ZECO's general budget, the status of the prepaid meter rollout and prepaid meters' popularity among ZECO customers. Following these interviews, we returned to relevant newspaper articles, and expanded our analysis to transcripts of government proceedings involving ZECO (which we translated from Swahili). We conducted follow-up interviews with utility staff, incorporating the knowledge from our field

observations and our document analyses. These interviews took place in ZECO offices.

5. Results

We begin by summarizing the socio-economic characteristics of our research sample. Households without access to electricity and likely to be living in extreme poverty were not included in this study.¹² Clear-cut income levels are difficult to capture in Unguja. Many households have transient members, who, depending on age, may or may not contribute to household income. Some heads-of-household have multiple wives and multiple homes, further complicating total income assessments. Furthermore, it became clear early in the interviewing stage that participants were uncomfortable explicitly addressing income; they were perhaps simply unsure, as common jobs found on the island and among our sample include self-employed, short-term contract, agriculture, and tourism jobs. These vary seasonally and create variable cash flows from month to month.

We divided our sample study into bottom, middle, and top socio-economic tiers in order to present a nuanced representation of Unguja's socio-economic levels. To this end, we placed households in each tier after cross-checking the OPHI data and the 2014 wage report (Tijdens et al., 2014) with our own observations of household assets, as well as answers to questions regarding our respondents' job status and size of family (Table 1 shows a summary of socio-economic characteristics per region). Reported income is unreliable in Zanzibar (as described above), so the following offers a glimpse of a top-tier household in this economy: at least one individual working a consistent job (not self-employed or owner of a small household business), on average fewer than four children, at least one piece of immovable furniture in the home (e.g. table or couch), one motorized vehicle, and an overall structurally sound home (see Online Appendix Figs. A.1 and A.2 for photos of typical low-, middle-, and top-tier homes).

For this study, the electrical devices owned by the households were only a partial marker of socio-economic status (Fig. 2). Furthermore, we found no clear pattern between appliances owned and reported monthly electricity consumption. The Y-axis in Fig. 2 represents devices owned by participants; these are vertically stacked in increasing order of their typical electricity consumption, or load size (see Table A.1). Although there is an increase in the diversity of appliances from bottom- to top-tier households, many appliances across all groups were found broken or apparently unused (e.g. clothes were piled on top of electric ovens, or fridges were unplugged, or appliances were tucked away in dark corners). In the rest of this section, we lay out our findings on the terms of commodification for electricity services and the human relationships underlying these terms. We contrast the postpaid and prepaid systems and highlight both user and provider perspectives.

5.1. The terms of commodification and the user: Debt versus the dark

The process by which users pay differs in postpaid and prepaid systems, not only in the timing but also in the mechanics. For some in Unguja, the postpaid system was complicated, making prepaid systems desirable by virtue of their simplicity. The postpaid billing system required all payments to be taken to the main offices in Stone Town. Those far from the ZECO office could make their

¹¹ Glaser and Strauss (1967) originated the method of constant comparison, whereby a few initial concepts and processes are identified in the setting of the study; data collection is based on the researcher's initial understanding of the phenomenon of interest; the data are systematically coded around the initial concepts (Corbin & Strauss, 1990); and the next round of data collection is purposive and draws on emergent concepts from the previous rounds. Thus the full scope of data collection cannot be laid out in advance, nor can pre-held hypotheses be tested.

¹² Our work and its findings, therefore, may not apply to the very poorest citizens of Unguja; it can justifiably be argued that the rights of those with no electricity connections are even more unmet than those with connections but only tenuous access to the service. We thank an anonymous reviewer for bringing our attention to this.

Table 1
Regional and Sample Characteristics.

Region	Unguja		Sample	
	Households (#)	Poverty Incidence (%)	Interviews (#)	Bottom Tier (%)
Kaskazini	39,884	58	18	35
Kusini	24,612	20	9	33
Mjini Magharibi	126,314	35	23	5

Regional and Sample Characteristics. Number of households and poverty incidence in Kaskazini (North), Kusini (South) and Mjini Magharibi (Town/West) regions of Unguja (shown in Fig. 1b). The right columns represent the sample population.

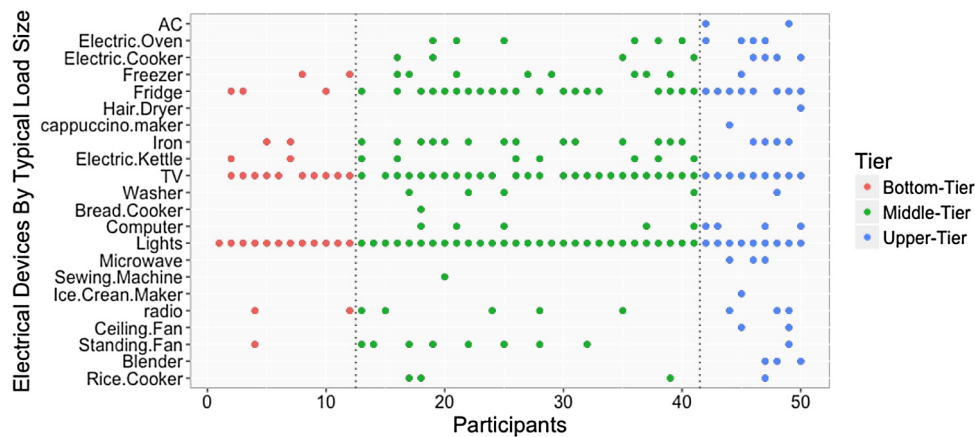


Fig. 2. Devices Owned by Participants. The Y-axis represents devices owned by participants, vertically stacked in increasing order of their typical electricity consumption. The X-axis represents participants, grouped in bottom-, middle-, and upper- tiers (in that order), divided by dashed lines.

payment to ZECO staff during monthly collection visits, but suspicion and anxiety resulted if their payments were somehow unaccounted for through the process (similarly noted in Winther (2012)). In Nungwi, a village in the far north region, for instance, one interviewee summarized his sole complaint with the postpaid system:

[W]e are thankful [to ZECO] but in the payment procedures, it's important for them to place a good procedure – it's necessary for them to just come a couple of days or one day before, before they come to cut electricity off [from] someone that hasn't paid. Like today, you go to pay, you get your receipt, you walk to your house [you] return to your home and there isn't any electricity – it's an interruption. This does upset me. It is the number one annoyance I have. Number one.

Many with postpaid meters made the (often) long trip to ZECO headquarters just to avoid such complications. ZECO streamlines the payment process for prepaid meters by placing more locations around the island to purchase top-ups.

The main difference between the user experience with prepaid and postpaid meters was the perceived control over electricity usage and hence over money. In principle, of course, the user can control his/her use of electricity regardless of the timing of payment: what changes with shifting the timing is the consequences of those choices, and the perception of control over his/her choices. Our respondents reported a significant overall preference for prepaid meters, especially at the middle-tier. Fig. 3 shows the number of responses favoring prepaid versus postpaid at the bottom-, middle-, and top-tiers, separated by whether the user had personal experience with only one or both types of meters. We note that no experience with a meter does not imply no knowledge. Participants regularly interacted with a neighbor's meter reader, helped a family member top-off their prepaid meter, or visited a family member with a different meter.

The users in our study, whether they preferred prepaid, postpaid, or were neutral, displayed a complex web of preferences, fears and insecurities. The postpaid meter left customers in debt to the utility at the end of the billing period. Users in our study whose debt felt manageable expressed anxiety over disconnections with prepaid meters. In general, the minority with a preference for postpaid meters felt that, even if money was tight, the postpaid system was lenient enough to allow a minimum necessary level of consumption: “debt you [can] pay off little by little, but while you are paying you can keep using it.” Users who feared that their debt would accumulate thought that prepaid meters managed their consumption, and allowed them to use only what [they] could afford. In effect, they preferred the risk of a blackout to the risk of increasing arrears. Socio-economic tiers among our respondents were not unambiguous predictors for who preferred post- or pre-, rather, the lowest levels of consumption were associated with a clear preference for postpaid. Those who lived with no more than a fan, some lights and a TV highly valued the security of continued services. Fig. 4 shows the relationship between the interviewee's reported monthly consumption and his/her preferred metering device (those with unclear or no preference are not listed). The data points correspond to respondents, while the horizontal lines indicate the median consumption for each preference group.

5.2. The terms of commodification and the utility: Secure payments, lower costs

For the service provider, there were clear advantages to using prepaid meters. The shift in the timing of payment committed their customers to paying prior to consumption, so a revenue stream was created irrespective of short-term provision. This shift offered ZECO the possibility of reducing their debt burden to the mainland utility, both by reducing user nonpayment and by eliminating the costly task of following up on arrears. In proceedings from a 2009

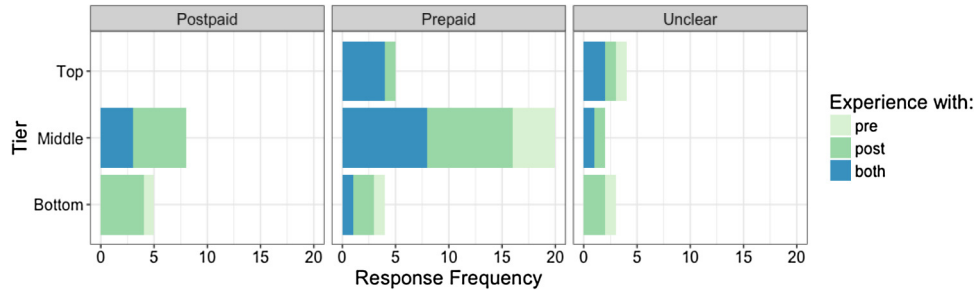


Fig. 3. Meter Preference by Tier Group and Experience. Fig. 3 shows the number of responses favoring prepaid versus postpaid per tier, and separated by whether the user had personal experience with only one or both types of meters.

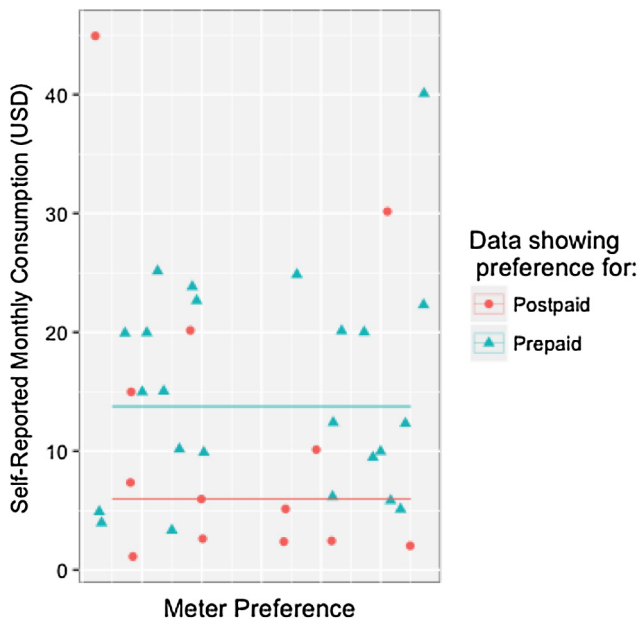


Fig. 4. Meter Preferences by Reported Monthly Consumption. The Y-axis represents interviewee’s reported monthly consumption and the X-axis his/her preferred metering device. Data points correspond to respondents, and horizontal lines indicate the median consumption for each preference group (the top line corresponds to prepaid preference, and the bottom line to postpaid).

meeting held by the Zanzibar Assembly, a ZECO representative stated:

[Honorable] Speaker, [ZECO] continues with its plan to monitor the sale of electricity debt for the purposes of reducing arrears from customers. This program has greatly helped to reduce ZECO’s debt from Tsh 6.3 billion to Tsh 5.5 billion during the 2008/2009 fiscal year . . .The intention of [ZECO] is to continue with the “Pay your bill” campaign due to its success in ensuring that debt continues reducing (Govt. of Zanzibar, 2009, p 31).

The representative follows this summary with the status of current work concerning debt and the “Pay Your Bill” campaign: the installation of 20,000 prepaid meters was underway, only a few thousand remained (Nordic Consulting Group, 2009, p 9). In a similar vein, in its 2009 report on Zanzibar-related electrification projects (support for prepaid meters included), the Nordic Consulting Group¹³ claimed that “between [sic] April to September 2008 ZECO reports a loss of energy of 26% in Unguja (energy purchased compared to energy sold). This is still high but lower than in previous years, when the loss of energy to a large extent also included energy

delivered but not paid for due to failures in billing and meter reading routines” (Nordic Consulting Group, 2009, p 9). With donors such as the World Bank providing much of the capital for prepaid installations (World Bank Group, 2003b, 2003a), ZECO staff told us that they were waiting to replace more postpaid meters as soon as the next tranche of money was made available.

5.3. Relationships embedded within the modes of payment

Each mode of payment was underpinned by a set of implicit and explicit relationships between the user and the provider, and the user and the service itself. Table 2 shows how these roles change when prepaid meters replace postpaid ones. The metering device has three functions: monitoring use and determining payment, disconnection and restoration, and setting the terms of credit. The prepaid regime signals a more visible role for the electric meter itself for the first two functions, effectively placing the utility at a distance from its own measurement device (and from the user). For the third function, prepaid systems move the upfront payment for electricity from ZECO to the user, therefore the customer (in effect) lends money to the utility before receiving any services. These changing roles and associated relationships are mediated by how the work of the meter is seen in each payment regime.

5.4. Relationship between user and the provider

By streamlining electricity payment, prepaid systems remove the consistent monthly engagement of the user with the meter reader. The meter reader’s monthly visits were a source of tension for some and a source of information for others. An older male respondent noted that his long relationship with the meter reader assured him that his electricity bill would not be miscalculated. As a postpaid customer, he said, “right now, if he doesn’t come I have his number. . .I was [also] taught how to read what number [the meter is at].” Others, however, complained that the meter readers failed to provide adequate information, making prepaid meters more attractive: “I like [prepaid] better than the ring meters

Table 2 Actors in Postpaid and Prepaid Regimes.

Function	Actors	
	Postpaid-	Prepaid-
Monitoring Use & Determining Payment	1. ZECO 2. Meter Reader 3. User 4. Meter	1. ZECO 2. Meter 3. User
Disconnection and Restoration	1. ZECO 2. User	1. Meter 2. User
Lender	1. ZECO	2. User

¹³ See <http://www.ncg.dk/>.

because, with those, we do not understand [what's happening] and the utility doesn't explain to us what's going on."

The meter reader's connection to the utility reflected poorly on the utility when users suspected that the reading of the meter was improper. Several participants expressed distrust of ZECO staff and its meter readers (also Winther, 2012); they frequently used the words "cheated" and "corrupt" while discussing their postpaid electricity bills: "the people at ZECO, they cheat you." They noted large discrepancies between their perceived consumption and the monthly bill for that consumption. For some, this "cheating" drove their preference for prepaid: "Given no problems with corruption, I would prefer the old meters because I used less electricity."

Discrepancies between the meter readings and perceived consumption were also common among prepaid users. In such cases, however, there appeared to be no meter reader and its associated "cheating" utility to blame; the discrepancy was routinely attributed to the meter itself: "It runs too fast. The *mita ya zamani* (old meter) gave more units." Or: "[prepaid meters], they run out fast; [prepaid] uses more power." A top-tier user explained her frustrations regarding prepaid meters: "The other day I went to the utility's offices, and I told them I think there is something wrong with my [prepaid meter] because most of the time I'm at work and my husband most of the time is at work, so why is it running out so fast?"

5.5. Relationship between user and the service itself

We found substantial evidence that consumers self-regulated their electricity consumption in the prepaid regime. When substitutes were available and when the meter was "running too fast", prepaid users switched from electrical appliances to traditional devices that used biomass-based fuels. This was clearly a response to scarcity and the need to avoid sudden disconnection. For example, bread-making is frequently done in electrical ovens and several respondents baked breads to sell. When money was tight and units on prepaid meters were low, some turned (back) to charcoal or wood stoves: "Many times [the units run out], therefore we use a wooden cooker." Similarly, rice cookers and water boilers were used differently with postpaid and prepaid electricity services. Unprompted, one interviewee explained that she stopped using her electric rice cooker once she switched to prepaid meters. After noticing that her units ran down faster when using a rice cooker, she said, she returned to older methods for cooking. For lighting, kerosene or candles were used as alternatives: "[W]hen you don't have money you can [just] use candles."

6. Discussion and conclusion

Our work offers a critical look at new and old forms of electricity commodification in Sub-Saharan Africa. Using a case-study approach, we investigated the ongoing switch from postpaid to prepaid meters in Unga, Tanzania. We explicitly compared perceptions and preferences of prepaid and postpaid meter users in this transitory regime. By viewing electricity access and use not only as a service, but also as a set of relations between the user and the provider, and between the user and his/her electricity, we show how the change in payment-timing and metering technology reshapes implicit relations among the three. In particular, the utility has set the stage for a less visible, seemingly distant relationship with its customers (see Graham & Marvin, 2001): one that shields it from customer dissatisfaction through the reification of the prepaid meter. We argue that the shift away from a provider- and user-centered relationship to a more overtly techno-human one presents individuals with a new set of vulnerabilities as well

as opportunities. The shift may not be fully compatible with a commitment to the right to basic electricity.

Prepaid meters have been widely critiqued as tools of control and disconnection over lay citizens; our study shows that they do seem to exert control over everyday patterns of cooking and lighting, forcing the user to watch her limited units and her limited cash. Nevertheless, our interviews and content analyses of primary documents revealed broad support for the prepaid meter by users and the provider, both of whom expressed significant concerns over debt. The willingness by domestic users to relinquish control to the meter is a testament to their financial insecurity. In welcoming (and reifying) the prepaid meter with its automated disciplining mechanism, users project stronger fears of being in debt than being without their lights, their TVs, and their cookers. The lurking fear of disconnection is real, but it is often preferable to the "corrupt" utility staff, the onerous payment method for the *mita ya zamani*, and unmanageable arrears. The term "reification" is used as a critique in the literatures on technology and society (e.g. Casey, 1995; Levidow, 1998; Loftus, 2006). Our study suggests that this critique must be tempered in the context of a utility whose customers distrust it, and an economy in which consumers would rather revert to candles and charcoal than to rack up debt.

This finding casts some doubt on the alleged "culture of nonpayment" in SSA. A 2008 World Bank study on modern services in SSA found that all income quintiles had significant nonpayment incidences, and concluded that nonpayment within "the richest quintiles suggests problems of payment culture alongside any affordability issues" (Banerjee et al., 2008, p 30; also cited in Foster et al. (2010, p 91) and Rosnes & Shkaratan (2011, p 113)).¹⁴ However, our participants, many of whom expressed frustrations with their inability to meet monthly payments, nonetheless endorsed a meter that enables constant surveillance and, in effect, makes nonpayment obsolete. This choice cannot stem from a "culture" of nonpayment: most respondents preferred a pay-by-usage regime.

Among the lowest-consuming users, however, postpaid meters brought security from disconnection; this led to a preference for the old technology. They could pay off their debt gradually while continuing to use essential electricity services. Prepaid meters are promoted by pointing out that low-income users can consume in accordance with their cash flow: they can top up their kWh in small quantities. The other side of that argument, though, is that postpaid meters allow users to pay off their debt in small quantities. For users whose needs amounted to lighting, and the occasional TV or fan, the insecurity of small debts to be paid off in small bits can be much less worrying than the insecurity of sudden disconnection. Postpaid meters offer such users an important safety net, allowing usage even when they cannot afford it.

From the utility's perspective, the cost of serving low-income communities has proven to be financially overwhelming. In March 2017, President Magufuli of Tanzania ordered the Zanzibari government to start paying off their debt to TANESCO or face an island-wide disconnection (The Daily Nation, March 20, 2017). As ZECO continues to subsidize electricity rates with users already struggling to pay their bills, it is left in the challenging position of increasing revenue through other means. Through calls to eliminate nonpayment, the prepaid meter has become a favored tool. With a substantial portion of their debt coming from government institutions and larger users, however, the prepaid option has its limits unless all – or at least most – users switch to a prepaid

¹⁴ For this the study the quintile range falls between households making "\$50 per month in the lowest quintile to no more than \$400 per month in the highest income quintile, except in middle-income countries, where the richest quintile has between \$600 and \$1,200 per month" (Banerjee et al., 2008, p viii). Tanzania is a low- rather than middle-income country, therefore the lower range is more relevant.

system. In the meantime, the ordinary citizen, who is responsible for the smaller portion of ZECO's debt, carries the financial and discursive responsibility for removing this debt.

We have argued that at the core of the electricity service system is a set of embedded relationships and perceptions, and that the advent of the prepaid meter has brought about a technologically-induced reshaping of these relationships. With the shadow of mismanagement hovering over Unguja's electricity sector, the reification of the prepaid meter shields ZECO from consumer ire. Rather than ZECO taking the blame for inadequate levels of service, it is now the *mita mpya* that runs too fast. By adopting prepaid meters, the utility severs the relationship between the meter reader and the user, making the *mita mpya* the de facto "face" of ZECO. By severing this relationship, the utility inadvertently removes an avenue of information for low-income or elderly users. The lack of a human interface at the user end is the other side of the efficiency of metering and billing argument with which prepaid meters are promoted. Finally, the mode of commodification determines the creditor/debtor relationship between utility and user: the utility offers services prior to payment in a postpaid regime, and thus acts as a creditor to users. This relationship flips with a prepaid regime, in which the users lend money (interest-free) to the utility, and get paid back as they consume the service. As lenders, users are doubly vulnerable when the quality of the service is low, which is the case in many SSA regions including Zanzibar (Eberhard et al., 2008); it is quite possible to pay in advance for electricity and then not get it when needed if ZECO is supply constrained for whatever reason (also Gupta, 2015). A recent World Bank report asserts that utilities should "consider pros and cons of mandating prepaid meters if service quality is poor," as a prepaid regime might lead to customers paying "in advance for electricity not delivered when needed" (Kojima & Trimble, 2016, p 30). As our research shows, however, the World Bank and others continue to promote prepaid meters across SSA.

Looming over the laudable language and earnest intentions of SDG 7 is the reality of self-regulation and self-rationing among prepaid meter users. While access to electricity is promoted for its potential to reduce polluting fuels in the home, and their associated negative health impacts (Smith, 2002; Fullerton, Bruce, & Gordon, 2008), our findings suggest that prepaid meters may incentivize the return to these fuels when cash is not available or units run out. Periodically returning to cooking with biomass is particularly damaging to the health of household cooks, who tend to be women. Prepaid users also self-regulate their consumption to avoid being in the dark; the frequency with which this phrase came up in our research indicates that it reflects genuine anxiety even among those who preferred prepaid to postpaid systems. Sudden and automatic disconnection arguably puts SDG 7 at risk of not being met for the most vulnerable, and thus at risk of not being met for all.

Postpaid meter regimes may have similar outcomes if users remain perpetually disconnected by the utility or strictly budget their own consumption. Yet by claiming that prepaid meters benefit poor customers by removing the risks of disconnection – because of vigilant self-regulation, and allowing access only when disposable cash is available – many reports ignore the realities of prepaid payment regimes. We do not argue that cost recovery in the electricity sector is unimportant for a utility or for a state. We do find that the prepaid regime can deny service at the point-of-use even when the user is unable to pay. If access to electricity in Africa becomes more and more contingent on payment prior to use, with no guaranteed lifeline consumption, this is not compatible with a commitment to universal basic access. As one of our participants succinctly put it: "With prepaid [meters] – no money, no connection."

Acknowledgments

We wish to thank members of the Energy and Resources Group for their helpful comments and insight throughout the course of this work, in particular Duncan Callaway and the Water Group. We thank Katie Epstein, Zach Burt and the members of the UCB Political Science Africa Research seminar – led by Leo Arriola – for their useful suggestions. Finally, we wish to thank the Zanzibar community for their time and hospitality.

This project was funded by an Art Rosenfeld Grant through the Berkeley, Energy, and Climate Institute, U.C. Berkeley, a Charles K. Birdsall Fellowship through the Energy and Resources Group, a DIL Innovate grant through the Development Impact Laboratory, Blum Center for Developing Economies, U.C. Berkeley, and a J-PAL Governance Initiative grant through the Abdul Latif Jameel Poverty Action Lab. The funders had no role in the research itself.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.worlddev.2018.01.007>.

References

- Alleyne, M. T. S. C., & Hussain, M. M. (2013). *Energy subsidy reform in Sub-Saharan Africa: Experiences and lessons*. International Monetary Fund.
- Auriol, E., & Blanc, A. (2009). Capture and corruption in public utilities: The cases of water and electricity in Sub-Saharan Africa. *Utilities Policy*, 17(2), 203–216.
- Banerjee, S., Wodon, Q., Diallo, A., Pushak, T., Uddin, E., Tsimpo, C., et al. (2008). Access, affordability, and alternatives: Modern infrastructure services in Africa.
- Baptista, I. (2015). 'We Live on Estimates': Everyday Practices of Prepaid Electricity and the Urban Condition in Maputo, Mozambique. *International Journal of Urban and Regional Research*, 39(5), 1004–1019.
- Bayat, A. (2004). Globalization and the Politics of the Informals in the Global South. *Urban Informality: Transnational Perspectives from the Middle East, Latin America and South Asia*, Lexington Books, Lanham.
- Bayissa, B. (2008). A Review of the Ethiopian Energy Policy and Biofuels Strategy. In *Digest of Ethiopia's National Policies, Strategies and Programs* (pp. 209–237). Addis Ababa: Forum for Social Studies.
- Bayliss, K., & McKinley, T. (2007). Privatising Basic Utilities in Sub-Saharan Africa: The MDG Impact, IPC Policy Research Brief No. 3.
- Briceño-Garmendia, C., & Shkaratan, M. (2011). Power tariffs: caught between cost recovery and affordability.
- Casey, C. (1995). *Work, self, and society: After industrialism*. Psychology Press.
- Corbin, J., & Strauss, A. (1990). Grounded theory research: Procedures, canons and evaluative criteria. *Zeitschrift für Soziologie*, 19(6), 418–427.
- del Granado, F. J. A., Coady, D., & Gillingham, R. (2012). The unequal benefits of fuel subsidies: A review of evidence for developing countries. *World Development*, 40(11), 2234–2248.
- Eberhard, A., Foster, V., Briceño-Garmendia, C., Ouedraogo, F., Camos, D., Shkaratan, M., et al. (2008). Underpowered: the state of the power sector in Sub-Saharan Africa. Background paper 6.
- Effah, E., & Owusu, K. B. (2014). Evolution and Efficiencies of Energy Metering Technologies in Ghana. *Global Journal of Research In Engineering*, 14(6).
- Estache, A. (2008). *Infrastructure and development: A survey of recent and upcoming issues* (Vol. 2) DC: The World Bank Washington.
- Fankhauser, S., & Tjepic, S. (2007). Can poor consumers pay for energy and water? An affordability analysis for transition countries. *Energy Policy*, 35(2), 1038–1049.
- Feenberg, A. (2002). *Transforming technology: A critical theory revisited*. Oxford University Press.
- Foster, V., Briceño-Garmendia, C., et al. (2010). *Africa's infrastructure: a time for transformation*. World Bank Publications.
- Foucault, M. (1977). Discipline and Punish, trans. Alan Sheridan (New York: Vintage, 1979) 191.
- Fullerton, D. G., Bruce, N., & Gordon, S. B. (2008). Indoor air pollution from biomass fuel smoke is a major health concern in the developing world. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 102(9), 843–851.
- Ghanadan, R. (2012). Connected geographies and struggles over access: Electricity commercialisation in Tanzania. *Electric Capitalism. Recolonising Africa on the Power Grid*.
- Glaser, B., & Strauss, A. (1967). The discovery of grounded theory. 1967. Weidenfield & Nicolson, London, 1–19.
- Google Maps (2017). The United Republic of Tanzania. <https://www.google.com/maps/place/Tanzania/@-6.1021661,34.1716811,7z/data=!4m5!3m4!1s0x184b51314869a111:0x885a17314bc1c430!8m2!3d-6.369028!4d34.888822?hl=en>.

- Govt. of Zanzibar (July 2009). Zanzibar Assembly's Thirteenth Meeting on July 9th, 2009 (91). <http://zanzibarassembly.go.tz/Hansard/2009/bg-july/kikao-cha-kumi-na-tatu.pdf>.
- Govt. of Zanzibar, October 2011. Revisited Zanzibar Development Vision 2020. Working document. <http://mpiangonz.go.tz/wp-content/uploads/2015/01/RevisitedZanzibarVision2020>
- Govt. of Zanzibar (May 2015). Zanzibar Socio – Economic Survey 2014: Preliminary Statistical Report. Office of the Chief Government Statistician Zanzibar.
- Graham, S., & Marvin, S. (2001). *Splintering urbanism: Networked infrastructures, technological mobilities and the urban condition*. Psychology Press.
- Gupta, A. (2015). An Anthropology of Electricity from the Global South. *Cultural Anthropology*, 30(4), 555–568.
- Halpern, J., Kenny, C., & Dickson, E. (2008). *Deterring Corruption and Improving Governance in the Electricity Sector*. Washington, D.C.: World Bank.
- Harris, C. (2003). *Private participation in infrastructure in developing countries: trends, impacts, and policy lessons*. No. 5. World Bank Publications.
- Issa, Y. (2014). Tanzania: Zanzibar Utility Firm Queries TANESCO's Over Sh70 Billion Debt. <http://allafrica.com/stories/201401200795.html>.
- Jack, B. K., & Smith, G. (2016). *Charging Ahead: Prepaid Electricity Metering in South Africa*. Tech. rep., National Bureau of Economic Research.
- Jaglin, S. (2008). Differentiating networked services in Cape Town: Echoes of splintering urbanism? *Geoforum*, 39(6), 1897–1906. <https://doi.org/10.1016/j.geoforum.2008.04.010>.
- Jaglin, S., & Dubresson, A. (2016). *Eskom*. UCT Press Electricity and Technopolitics in South Africa.
- Jütten, T. (2010). What is Reification? *A Critique of Axel Honneth*. *Inquiry*, 53(3), 235–256.
- Keelson, E., Boateng, K.O., & Ghansah, I. (2005). Low Cost Early Adoption Procedures for Implementing Smart Prepaid Metering Systems in African Developing Countries.
- Kemausuor, F., & Ackom, E. (2017). Toward universal electrification in Ghana. *Wiley Interdisciplinary Reviews: Energy and Environment*, 6(1).
- Kojima, M., Bacon, R., & Trimble, C. (2014). Political economy of power sector subsidies: a review with reference to Sub-Saharan Africa. Washington: World Bank document 89547.
- Kojima, M., & Trimble, C. (2016). *Making Power Affordable For Africa and Viable for Its Utilities*. Report. World Bank. <http://hdl.handle.net/10986/25091>.
- Lampietti, J.A., Banerjee, S.G., & Branczik, A. (2007). People and power: electricity sector reforms and the poor in Europe and Central Asia. World Bank Publications.
- Levidow, L. (1998). Democratizing technology or technologizing democracy? Regulating agricultural biotechnology in Europe. *Technology in Society*, 20(2), 211–226.
- Loftus, A. (2006). Reification and the dictatorship of the water meter. *Antipode*, 38(5), 1023–1045.
- Lukács, G. (1971). History and class consciousness: Studies in Marxist dialectics. Vol. 215. MIT Press.
- Malama, A., Mudenda, P., Ng'ombe, A., Makashini, L., & Abandaet, H. (2014). The Effects of the Introduction of Prepayment Meters on the Energy Usage Behaviour of Different Housing Consumer Groups in Kitwe, Zambia. *AIMS Energy*, 2(3), 237–259.
- Marx, K. (1867). Capital, volume I.
- Maulid, O. (2015). From the House of Representatives Zanzibar. <http://www.zanzinews.com/2015/06/kutoka-baraza-la-wawakilishi-zanzibar.html>.
- Mburu, P. T., & Sathyamoorthi, C. R. (2014). Switching from Post-paid to Pre-paid Models: Customer Perception and the Organisational Role in Managing the Change: A Case Study of Botswana Power Corporation. *Journal of Management Research*, 6(3), 175.
- Mirafab, F., & Wills, S. (2005). Insurgency and spaces of active citizenship the Story of western cape anti-eviction campaign in South Africa. *Journal of planning education and research*, 25(2), 200–217.
- Miyogo, C. N., Nyanamba, S. O., & Nyangweso, G. N. (2013). An Assessment of the Effect of Prepaid Service Transition in Electricity Bill Payment on KP Customers, a Survey of Kenya Power, West Kenya Kisumu. *American International Journal of Contemporary Research*, 3(9), 88–96.
- Mtulya, A. (2017). Magufuli directs Tanesco to cut power supply to Zanzibar over debt. Online, posted 6-March-2017, accessed 22-September-2017. <http://www.theeastafrican.co.ke/news/Cut-power-to-Zanzibar-Magufuli-tells-Tanesco/2558-3839366-5iqswvz/index.html>.
- Mwaura, F. M. (2012). Adopting electricity prepayment billing system to reduce non-technical energy losses in Uganda: Lesson from Rwanda. *Utilities Policy*, 23, 72–79.
- NBS (2013). 2012 Population and Housing Census. Tech. rep., National Bureau of Statistics. <http://meac.go.tz/sites/default/files/Statistics/TanzaniaPopulationCensus2012.pdf>.
- Nordic Consulting Group (2009). End-review of Phase IV and Extension of the Zanzibar Rural Electrification Project: Final Report April 2009. Tech. rep., Nordic Consulting Group.
- Northeast Group (2014). *Sub-Saharan Africa Electricity Metering: Market Forecast (2014 to 2024)*. Northeast Group LLC: Report.
- Otomwa, R. (2014). Effect of prepaid electricity billing on revenue collection costs at Kenya power company. Ph.D. thesis, University of Nairobi.
- OPHI (2013). OPHI Country Briefing 2013: Tanzania. <http://www.ophi.org.uk/wp-content/uploads/Tanzania-2013.pdf>.
- Petrovic, G., 1983. A Dictionary of Marxist Thought.
- Plançq-Touradre, M. (2004). Services d'eau et d'électricité au Cap, ou comment la sortie de l'apartheid fabrique des débranchés. *Flux*, 2, 13–26.
- Quayson-Dadzie, J. (2012). Customer Perception and Acceptability on the Use of Prepaid Metering System in Accra West Region of Electricity Company of Ghana. Ph.D. thesis, Institute Of Distance Learning, Kwame Nkrumah University of Science and Technology.
- Rosnes, O., & Shkaratan, M. (2011). Africa's power infrastructure: investment, integration, efficiency. World Bank Publications.
- Ruiters, G. (2007). Contradictions in municipal services in contemporary South Africa: Disciplinary commodification and self-disconnections. *Critical Social Policy*, 27(4), 487–508.
- Sagar, A. D. (2005). Alleviating energy poverty for the world's poor. *Energy Policy*, 33(11), 1367–1372.
- Sahel Standards News (2016). Prepaid Metering to Attract 11.4 billion Investment in 10 years. Online, posted 16-July-2016, accessed 02-January-2017. <http://sahelstandard.com/index.php/2016/07/06/prepaid-metering-to-attract-11-4-billion-investment-in-10years/>.
- Smith, K. R. (2002). Indoor air pollution in developing countries: recommendations for research. *Indoor air*, 12(3), 198–207.
- Tewari, D. D., & Shah, T. (2003). An assessment of South African prepaid electricity experiment, lessons learned, and their policy implications for developing countries. *Energy Policy*, 31(9), 911–927.
- The Daily Nation (March 2017). Zanzibar starts settling power debt after Magufuli directive. Online, posted 20-March-2017, accessed 02-April-2017. <http://www.nation.co.ke/business/Zanzibar-govt-starts-settling-Tanesco-debt-minister-says/996-3856776-xlkq6z/>.
- The Economist (2016). Ending energy poverty power to the powerless. Online, posted 27-February-2016, accessed 15-January-2017. <https://www.economist.com/news/international/21693581-new-electricity-system-emerging-bring-light-worlds-poorest-key>.
- The Guardian (2013). ZECO officials in illegal power scam. Online, posted January-2013, accessed August-2016. <http://www.ippmedia.com/fronted/functions/printarticle.php?7C=50600>.
- Tijdens, K. G., Besamusca, J., & Kahyarara, G. (2014). *Wages in Zanzibar: Wageindicator survey 2013*. WageIndicator Foundation, Amsterdam: Tech. rep.
- Trimble, C.P., Kojima, M., Perez Arroyo, I., & Mohammadzadeh, F. (2016). Financial viability of electricity sectors in Sub-Saharan Africa: quasi-fiscal deficits and hidden costs. <https://ssrn.com/abstract=2836535>.
- Tully, S. (2006). The Human Right to Access Electricity. *Electricity Journal*, 19(3), 30–39.
- United Nations (2015). Transforming our world: the 2030 Agenda for Sustainable Development. General Assembly 70 session 16301 (October), 1–35.
- van Heusden, P. (2012). Discipline and the new logic of delivery: Prepaid electricity in South Africa and beyond. *Electric Capitalism. Recolonising Africa on the Power Grid*, 229.
- 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), 670–693.
- Wamukonya, N. (2003). Power sector reform in developing countries: mismatched agendas. *Energy Policy*, 31(12), 1273–1289.
- Williams, J. H., & Ghanadan, R. (2006). Electricity reform in developing and transition countries: A reappraisal. *Energy*, 31(6), 815–844.
- Winkler, H., Simões, A. F., La Rovere, E. L., Alam, M., Rahman, A., & Mwakasonda, S. (2011). Access and affordability of electricity in developing countries. *World Development*, 39(6), 1037–1050.
- Winther, T. (2012). Electricity theft as a relational issue: A comparative look at Zanzibar, Tanzania, and the Sunderban Islands, India. *Energy for Sustainable Development*, 16(1), 111–119.
- World Bank Group (2003a). *Implementation Completion Report (ICR) Review – Tz-power Vi*. Tech. rep. Independent Evaluation Group. <http://lnweb90.worldbank.org/oeod/oeodoclib.nsf/DocUNIDViewForJavaSearch/8525682E0068603785256D55004FDF3?OpenDocument>.
- World Bank Group (2003b). Implementation Completion Report on a Credit in the Amount of 200 Million USD Equivalent to the United Republic of Tanzania for Tanzania Power VI Project. Tech. Rep. 26745, Energy Team Africa Region. <http://documents.worldbank.org/curated/en/264191468760799364/pdf/267450icr.pdf>.
- World Bank Group (2016a). International Development Association Project Paper On A Proposed Additional Credit In the Amount of Euro 62.8 Million To The Republic of Senegal For the Electricity Sector Support Project. Tech. Rep. PAD1815, World Bank.
- World Bank Group (2016b). Project Information Document (PID) Appraisal Stage: Gambia. Tech. Rep. PIDA27610, World Bank, DC.
- Yussuf, I. (2015). Isles owes billions in power bills. Online, posted February-2015, accessed 15-December-2016. <http://dailynews.co.tz/index.php/home-news/45146-isles-owes-billions-in-power-bills>.