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Pre-paid metering and electricity consumption in developing countries

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1 Introduction

Pre-paid electricity metering is expanding rapidly across the developing world. Pre-paid meters are seen as a smart technological solution to control non-payment of bills, electricity theft, and corruption. These meters can help extend electricity access, while improving the financial viability of electric utilities. Market forecasts project that an additional 126 million pre-paid electricity meters will be rolled out between 2016 and 2026, with investments totalling US $11 billion (Northeast Group, 2016).

On the other hand, relatively little research has tested the impact of pre-paid metering on customer electricity consumption, energy efficient behaviours, and electricity revenue generation in developing countries. Theory suggests that some aspects of consumer behaviour could increase and some reduce electricity use following the introduction of pre-paid metering.

Only one existing study tests the effect of pre-paid metering on electricity consumption in a developing country in a quasi-experimental setting. Jack and Smith (2020) found that customers who were shifted from post-paid to pre-paid metering in Cape Town, South Africa reduced their electricity consumption by 14%.

This Energy Insight reports on recent developments in the adoption of pre-paid metering in sub-Saharan Africa and South Asia and examines the effects of pre-paid metering on electricity consumption. We present preliminary results from our own study of the effect of pre-paid metering on electricity consumption in Dhaka, Bangladesh. We find that consumption falls by 17% after customers are switched to pre-paid meters. This is in line with Jack and Smith's South African data and studies from developed economies.

2 Pre-paid metering

Access to electricity in developing countries has grown rapidly in recent years (Burke *et al.*, 2018). Electricity is often highly subsidised at both the retail and wholesale levels in developing countries, which encourages inefficient use. While newly connected customers usually use little electricity at first, this can change rapidly as income increases (Wolfram *et al.*, 2012). In recent years, pre-paid electricity metering has been introduced in both developing and developed countries (e.g. the US, Germany, New Zealand, Australia, Ireland, and the UK). In the United States, utilities in 34 states offer some type of pre-payment plan for electricity, where they are used both to reduce non-payment of bills and as a demand-side management strategy (Jack and Smith, 2020).

Pre-paid meters require customers to purchase credit up-front and load it into their electricity meter. After recharging, the meter displays the available kWh the customer can consume. As long as a positive balance remains, the electricity flows, and when the balance reaches zero, the power automatically disconnects. There are currently two main types of pre-paid meters: smartcard meters and keypad meters. Smartcard meters require the customer to put credit onto a plastic card, which is inserted into the meter. To use a keypad meter, the customer purchases credit from a vendor and receives a code to type into the meter. Vendors may include banks, shops, post-offices, supermarkets, and electricity distribution company (DISCOM) shopfronts. Keypad meters may also allow online purchase using SMS or internet and mobile applications. Pre-paid meters can also be combined with smart meter features, such as time-of-use pricing or additional information provision in an in-home display.

In developing countries, pre-paid electricity meters provide a smart technological solution for electric utilities to eliminate non-payment, reduce electricity theft and corruption, and reduce the costs of supplying residential customers by eliminating the need for meter reading, simplifying bill payment, and bringing forward revenue. If pre-paid meters reduce electricity use and electricity is provided at a loss, they can further reduce the losses of electric utilities. Pre-paid meters reduce the political cost of disconnecting customers who don't pay (Jacome and Ray, 2018).

From the consumers' perspective, pre-paid electricity plans remove the 'bill shock' that comes at the end of the billing cycle and helps them budget (especially those with low and uncertain incomes). On the other hand, customers need to plan their credit purchases so they do not unexpectedly get

cut off. For example, pre-paid meter users in Nigeria complain that they cannot buy credit on Sundays or on holidays and may face other difficulties in purchasing credit and recharging their meters (Kambule *et al.*, 2018). If the customer loses the smartcard or code, it may be difficult to be reimbursed. Frequent electricity or mobile outages will also interfere in buying credit. Finally, customers are often required to pay for installing a pre-paid meter (Aliu, 2020).

3 Uptake of pre-paid metering

Our focus is on the Energy and Economic Growth Programme's regions of interest in sub-Saharan Africa and South Asia. Outside sub-Saharan Africa and South Asia, China, Indonesia, Brazil, and Argentina also have a significant number of households on pre-paid electricity metering.

3.1. Sub-Saharan Africa

In 1988, the South African utility Eskom was the first to introduce pre-paid metering in a developing country. Eskom aimed to supply electricity to large numbers of poor and geographically dispersed users in the years following the end of apartheid (Tewari and Shah, 2003; Bekker *et al.*, 2008). It would have been very expensive and difficult to read meters and to bill customers with very low electricity use in scattered rural locations, which often lacked formal addresses or postal service. Many potential consumers were illiterate (Tewari and Shah, 2003). In the following decades, pre-paid metering enabled the rapid expansion of residential access to electricity across South Africa. Since then, pre-paid metering has been introduced in many African countries, including those listed in Table 1. Some countries have been more successful than others in rolling out pre-paid meters.

The Power Holding Company of Nigeria (PHCN) and 11 private DISCOMs have made efforts to switch all electric customers to pre-paid meters. Customers can request to be switched to a pre-paid meter, but meters are often not available. Consumers have to pay for the meters, which are expensive and cost more than a post-paid meter (Aliu, 2020). Therefore, uptake is relatively low. In Ghana, about half of urban customers have pre-paid meters, but pre-paid meters have not been deployed in rural areas (Yakubu *et al.*, 2018).

In 2008, the Ethiopian Electric Power Corporation (EEPCo, since split into EEP and the Ethiopian Electric Utility (EEU)) made a deal with an Egyptian company to replace 120,000 post-paid meters with pre-paid meters in Addis Ababa and other cities across the country.[1] However, there seems to have been little progress since then, and strengthening collection rates was one of the foci of a 2019 reform proposal. Pre-payment meters were intended to play a part in this, and the government intended to introduce a digital payment platform to allow bills to be paid through bank transfers. Mobile money payments might be introduced at a later stage.[2]

By contrast, pre-paid metering has emerged as the universal model for retail electricity distribution in Mozambique, especially in urban areas. By 2013, 90% of customers in Maputo had pre-paid meters (Baptista, 2016).

In Rwanda, the public utility company Electrogaz (now the Rwanda Energy Group) adopted pre-paid electricity meters to reduce high non-technical energy losses. The first pre-paid meters were rolled out in 1995 and the programme was scaled up in 1999. By 2008, 80% of customers were on pre-paid metering (Mwaura, 2012).

Tanzanian electricity supply companies the Tanzania Electricity Company (TANESCO) and the Zanzibar Electricity Corporation (ZECO) introduced a shift in payment regime from post-paid to pre-paid meters to overcome operational efficiency and revenue collection challenges. At present, TANESCO connects all new small power users (<7500 kWh per month) using a LUKU keypad pre-paid meter. In order to reduce system loss by 12%, Tanzania has implemented a long-term plan for replacing all conventional meters with pre-paid meters by 2025 (Government of Tanzania, 2014).

[1] http://nazret.com/blog/index.php/2008/02/19/ethiopia_eepco_to_fully_replace_postpaid.
[2] www.africa-energy.com/article/ethiopia-government-plans-ambitious-utility-reforms.

Table 1: Pre-paid meter implementation in sub-Saharan Africa

Country	Inception/ pilot year	Large-scale implementation year	Implementing company/ authority	Type of pre-paid meter	Target area/population	Sources
Ethiopia	2005	2018	• EEU	• Smart keypad meters	• All residential customers	EEU, African Energy
Ghana	1994	2014	• Electricity Company of Ghana (ECG) • Northern Electricity Distribution Company–Volta River Authority (NEDco-VRA)	• Smart keypad meters	• Residential and commercial consumers • All major cities	ECG, Yakubu *et al.* (2018)
Kenya	2009	2013	• Kenya Power	• Smart keypad meters	• All residential customers	Kenya Power
Mozambique	1995	2016	• Electricidade de Moçambique (EDM)	• Smart keypad meters	• All residential customers	EDM, Baptista (2016)
Nigeria	2006	2015	• Nigerian Electricity Regulatory Commission (NERC) • Electricity DISCOMs • PHCN	• Smart keypad meters	• All residential customers	Arawomo (2017), Ibrahim-Dasuki *et al.* (2012), Smart Energy International, NERC
Rwanda	1995	1999	• Energy Development Corporation Ltd (EDCL)	• Smart keypad meters	• All residential customers	Mwaura (2012), Rwanda Energy Group, Smart Energy International
Sierra Leone	2009	2015	• National Power Authority (NPA) • Electricity Distribution and Supply Authority (EDSA)	• Smart keypad meters	• All residential customers	EDSA, Smart Energy International
South Africa	1988	2011	• Eskom	• Paper card meters • Smartcard meters • Smart keypad meters	• Residential customers • Low-income households • Geographically remote areas	Eskom, Jack and Smith (2020)

Tanzania	2007	2014	• TANESCO • ZECO	• Smart keypad meters	• All residential customers	TANESCO, Jacome and Ray (2018), Smart Energy International
Uganda	2012	2018	• Electricity Regulatory Authority (ERA) • Uganda Electricity Distribution Company Ltd (UEDCol)	• Smart keypad meters	• All residential customers	ERA, UEDCol, Pre-paid Energy Hub

3.2. South Asia

In recent years, South Asian countries have substantially expanded access to electricity and increased electricity generating capacity. However, electricity DISCOMs in these countries have suffered losses exacerbated by the non-payment of electricity bills, electricity theft, and corruption, which are enabled by the existing post-paid billing (Abbas *et al.*, 2018). Therefore, to reduce system loss, electricity theft, and corruption and to increase electricity bill collection and improve electricity service, utility companies are beginning to implement pre-paid electricity metering on a large scale.

In Bangladesh, pre-paid electricity meters were first introduced through two pilot projects in Dhaka and Chittagong in 2005. The Power Division of the Bangladesh government made a major policy change in 2014 planning to introduce pre-paid metering across the country. Four major electricity DISCOMs (Dhaka Electricity Supply Company Ltd (DESCO), Dhaka Power Distribution Company Ltd (DPDC), the Bangladesh Power Development Board (BPDB), and West-Zone Power Development Company Ltd (WZPDCL)) have already switched more than two million customers across different cities in Bangladesh to pre-paid meters.

In India, the state-owned Energy Efficiency Services Limited (EESL) under the Ministry of Power, Government of India, is implementing a smart pre-paid metering programme. EESL has installed over 1.2 million smart meters to date in four states—Gujarat, Uttar Pradesh, New Delhi, and Bihar. The Indian government aims to implement smart pre-paid metering throughout the country by 2023.[3]

Recently, the Nepali electricity authority has started implementing pre-paid electricity metering in Kathmandu and plans to scale the programme up with the help of the Asian Development Bank.[4] Finally, Pakistan is also implementing smart pre-paid metering in Islamabad, Peshawar, and Lahore with the help of the Asian Development Bank and is also planning to implement large-scale pre-paid metering soon.[5]

[3] www.bloombergquint.com/business/india-plans-to-spend-21-billion-on-smart-power-meter-rollout; www.hindustantimes.com/india-news/bring-in-prepaid-smart-meters-in-three-years-govt-to-states-and-uts/story-qaWjqrU0TAYFtZUwDUIFhI.html; www.hindustantimes.com/analysis/can-smart-meters-solve-india-s-electricity-problem-opinion/story-yOR2TEBTW3zPOm0knXBdPK.html; www.thehindu.com/business/smart-meters-come-in-handy-in-calculating-power-bills/article31568378.ece; www.ndtv.com/india-news/nitish-kumar-sets-deadline-for-installing-prepaid-electric-meters-in-bihar-2048055; https://government.economictimes.indiatimes.com/news/smart-infra/budget-2020-govt-to-convert-all-electricity-meters-into-smart-prepaid-meters-by-2022/73866539.

[4] www.nepalitelecom.com/2018/09/nea-smart-meters-electricity-kathmandu.html; www.adb.org/sites/default/files/publication/479181/nepal-smart-metering-road-map.pdf.

[5] www.smart-energy.com/regional-news/asia/smart-meters-iesco-adb/; www.dawn.com/news/1273314.

Table 2: Pre-paid meter implementation in South Asia

Country	Inception/pilot year	Large-scale implementation year	Implementing company/ authority	Type of pre-paid meter	Target area/population	Sources
Bangladesh	2005	2014	• Power Division, Government of Bangladesh • DESCO • BPDB • DPDC • WZPDCL	• Smartcard meters • Smart keypad meters	• All residential customers	Government of Bangladesh, DESCO, DPDC, BPDB, WZPDCL
India	2005	2018	• Stated-owned EESL • Power DISCOMs	• Smart keypad meters	• All residential customers	EESL, Economic Times
Nepal	2019	NA	• Nepal Electricity Authority (NEA)	• Smart keypad meters	• Urban residential customers	ADB
Pakistan	2018	NA	• Islamabad Electric Supply Company (IESCO)	• Smart keypad meters	• All residential customers in Islamabad	IESCO, Smart Energy International

4 Is pre-paid metering expected to reduce or increase electricity consumption?

The behavioural economics literature has shown that standard economic theories often fail to correctly predict consumer spending and behaviour (Kahneman, 2003). The mechanism used to pay for something can affect purchasing behaviour. Paying using cash tends to reduce future spending compared to spending with a credit card where the bill is only paid later (Soman, 2001). On the other hand, given a choice, consumers often prefer to pay up-front so that worrying about paying later does not interfere with enjoying consumption (Prelec and Loewenstein, 1998). This suggests pre-payment will raise consumption.

There are several channels through which pre-paid metering can change consumers' electricity use, including nudging, discounting, information provision, the costs of having no electricity (Qiu *et al.*, 2017), and mental accounting.

Nudging: Given that electricity spending is only a small portion of overall household expenditure and conventionally electricity is post-paid on a monthly basis, households are less trained at tracking and budgeting their electricity expenditure. Pre-paid metering reminds households repeatedly of the cost of electricity and the need to budget for it. Providing consumers with peer comparisons of household energy use is another type of nudge that is documented to reduce energy use, by 0.7% to 3.3% (Allcott and Rogers, 2014; Gleerup *et al.*, 2010; Andor *et al.*, 2020).

Discounting: People prefer to consume now rather than later and give less weight to future costs than immediate ones. Standard economic theory assumes that the rate at which they discount future costs and benefits is constant,[6] but behavioural economics shows that many consumers apply a much higher discount rate to the near future than to the far future, which results in bad decision making (Frederick *et al.*, 2002). If consumers only need to pay for their electricity in a month or maybe more, they will discount that future cost a lot relative to the benefits of using electricity now and so consume more electricity—but they may regret that decision when it is time to pay.

Information provision: While nudging reminds a customer about budgeting, the information provided by pre-paid metering can help them accurately budget their electricity consumption. In a post-paid scheme, consumers need to form an expectation about their use, which can often deviate from the realisation. If consumers underestimate their consumption, they will consume more than they would under full information and *vice versa*. Research shows that information provision usually reduces energy use. The use of in-home display of real-time prices has been found to be very effective in reducing electricity consumption. Analysing 12 separate trials in the US, Canada, Australia, and Japan, Faruqui *et al.* (2010) found that in-home displays alone reduce electricity consumption by 7%; when accompanied by pre-paid metering, the reduction is around 14%. A meta-analysis of 156 published trials of information-based strategies for household energy consumption found that individuals who participated in experiments reduced electricity consumption by 7.4% on average (Delmas *et al.*, 2013). Gans *et al.* (2013) report that adding in-home display to an existing pre-paid programme in Northern Ireland reduced electricity use by 11%–17%.

Costs of having no electricity: To avoid running out of electricity and having to travel to buy more credit, customers may consume less electricity to make sure they have enough until it is convenient to buy more (Qiu *et al.*, 2017).

Mental accounting: As discussed above, paying up-front can reduce the worry about paying later, potentially increasing consumption. On the other hand, payment inflicts pain, which suggests consumers will purchase less electricity. The strength of these two effects varies across individuals (Prelec and Loewenstein, 1998).

5 Does pre-paid metering reduce electricity consumption?

[6] Given net benefits in the current period of N_1, and in consecutive periods of N_2 and N_3, a constant discount rate implies that the consumer treats N_1, $\frac{N_2}{1+r}$, and $\frac{N_3}{(1+r)^2}$, where r is the discount rate (e.g. 0.05 or 5%), as equal amounts in their decision making.

Demand-side management interventions, including the introduction of pre-paid meters or meters that provide information on electricity use, have been successful in reducing energy consumption (Ferraro *et al.*, 2011; Allcott, 2016). However, most of the evidence comes from interventions in developed countries, with a few notable exceptions (e.g. Chen *et al.*, 2017; Sudarshan, 2017; Jack and Smith, 2020). Jack and Smith's (2020) study in Cape Town, South Africa, is the only quasi-experimental study of the introduction of pre-paid meters in a developing country. Table 3 compares their results and our own study, discussed in the next section, with a number of studies from developed economies.

Table 3: Reduction in electricity consumption due to the introduction of pre-paid metering

Location	Reference	Reduction in electricity consumption
Dhaka, Bangladesh	This study (Energy Insight)	17%
Cape Town, South Africa	Jack and Smith (2020)	14%
Woodstock, Ontario, Canada	Faraqui *et al.* (2010)	15%
Phoenix, Arizona, USA	Qiu *et al.* (2017)	12%
Kentucky, USA	Martin (2014)	11%
Oklahoma, USA	Ozog (2013)	11%

When using a pre-paid meter is a voluntary choice, customers who find it more difficult to control their electricity use or budget are more likely to choose to switch to pre-payment. Customers who are more interested in saving electricity might also switch in order to increase the information they get about their consumption. If this is true, the resulting reduction in electricity use is likely to be larger than that of the average consumer who is switched to a pre-paid meter by the electric utility, whether they want to switch or not. On the other hand, perhaps customers who switch still find it harder to budget after switching than the average consumer (Qiu *et al.*, 2017).

If we want to assess the effect of switching typical customers to pre-paid metering, then we cannot look at the raw outcomes of opt-in policies. Ideally, we would compare the consumption before and after the switch to pre-paid metering of customers who were switched by the utility with that of a control group.

In 2014–15, over 4,000 customers were switched to pre-paid metering in Mitchells Plain and other suburbs of Cape Town. Customers did not need to pay for the new meters. Meters were changed in 27 randomised groups, which means that customers who were not yet switched could act as the control group and allow the researchers to disentangle the effects of the change of meter from any other events that might have affected electricity consumption over this period. Jack and Smith found that pre-paid electricity metering reduced customers' electricity use by 14%, or by an average of 1.9 kWh per customer per day. These changes persisted for at least a year after the switch.

Electricity in Cape Town is priced on an increasing block tariff for both post-paid and pre-paid customers, with pre-paid customers moving up the tariff schedule based on cumulative purchases during the month. Jack and Smith argue that high-frequency price feedback makes the higher marginal price at higher levels of consumption more salient. Consistent with this, they observed bunching of total monthly usage around the largest tariff step for pre-paid customers (who purchase electricity and receive price feedback every three days on average) and no bunching for post-paid customers. This bunching can explain some of the reduction in electricity use.

There are a few studies on the association between electricity consumption and pre-paid metering in Nigeria. In Nigeria, many customers are unmetered and there are both post-paid and pre-paid meters. Customers who want a pre-paid meter can get one if it is available, so there is a large element of self-selection. Aliu (2020) found that pre-paid customers use less electricity than post-paid customer in Ojo, a suburb of Lagos, but post-paid users also have slightly higher income and education and larger households. As Aliu (2020)

estimated separate regression models for pre-paid and post-paid customers, his analysis does not tease out the effect of the meter type controlling for these factors. Arawomo (2017) found that pre-paid users in Ibadan take more energy saving actions than post-paid customers, but again pre-paid users are partly self-selected.

Casarin and Niccolier (2009) conducted a cost–benefit analysis of the adoption of pre-paid metering in Carmen de Areco, a small municipality in Buenos Aires Province that was the first to widely adopt electricity pre-paid meters in Argentina. While in 1996 the average pre-paid customer used less electricity than the average post-paid customer, by 2003 this had reversed. However, because the number of pre-paid customers increased, the composition of households differed significantly between the two groups, and tariffs were 5% lower for pre-paid customers, this comparison also does not tell us the effect of adopting pre-paid metering.

The Salt River M-Power programme located in Phoenix Arizona allows customers to switch to a pre-paid meter with in-home display. Qiu *et al.* (2017) compared the change in electricity use by households that joined the programme to that of a control group. As pre-paid users self-select, there is a potential selection bias. The researchers addressed this by using a matching method to construct a control group with similar characteristics to the group that switched to pre-paid metering. Electricity use fell 12%, or an average of 6.88 kWh per day in summer and 4.95 kWh in winter. Poorer customers and those with more debt to the electric utility prior to switching to the pre-paid programme tended to save more electricity after switching.

Martin (2014) used household-level monthly data from customers enrolled in pre-paid programmes at two Kentucky rural electric cooperatives. He uses a fixed-effects regression model to control for customer characteristics, but, as customers opt in, this doesn't fully address the self-selection issue. Pre-paid customers reduced their consumption by an average of 11% after enrolling in the programme, but this effect diminished the longer a customer was enrolled. Ozog (2013) reported similar results from Oklahoma. Faraqui *et al.* (2010) reported that Woodstock Hydro's Pay As You Go pre-payment plus in-home display programme (Ontario, Canada) reduced electricity use by 15%. Again, customers volunteered for the programme.

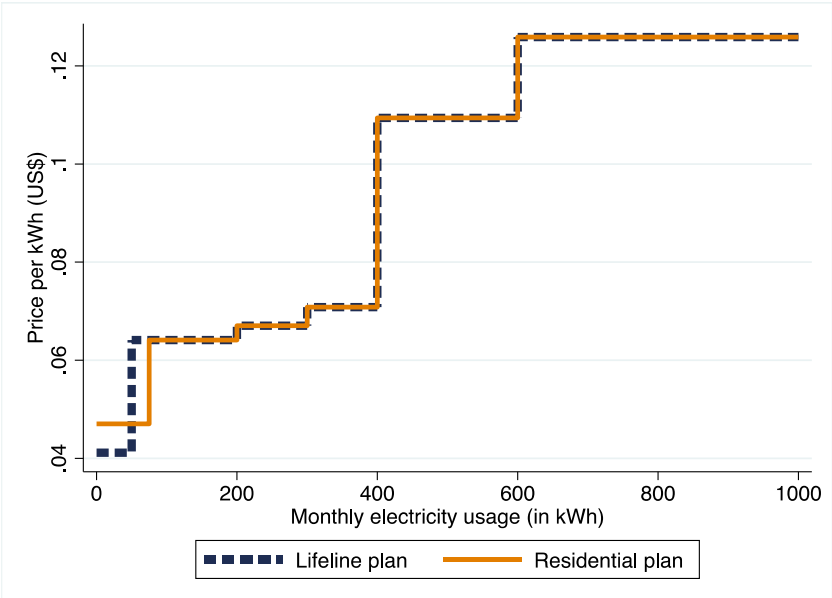
6 Bangladesh case study

As we discussed in the previous section, there is only one existing quasi-experimental study of the effects of pre-paid metering in a developing country context and none from South Asia or a low or lower-middle income country. We investigated the effect of introducing pre-paid metering in Bangladesh. We considered two areas in Dhaka serviced by the DPDC DISCOM: Ramna (the green circle in Figure 1) and Khilgaon (the red circle in Figure 1). In Ramna, DPDC has not yet implemented pre-paid metering, while DPDC implemented pre-paid metering in Khilgaon from January 2018. Customers are provided with a smart card or keypad type meter based on their preference.

Figure 1: Location of study areas in Dhaka Metropolitan Area

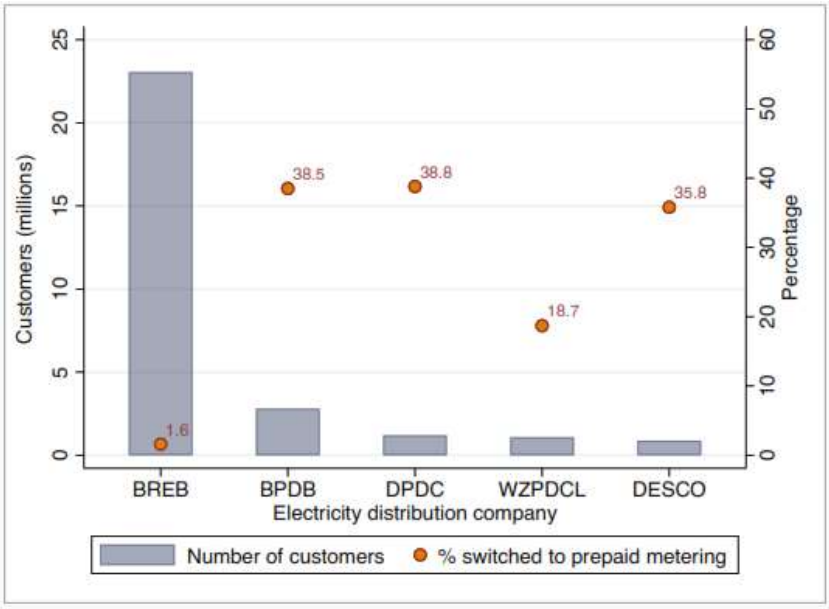
Electricity prices in Bangladesh are regulated both at the retail and wholesale levels. The Bangladesh Energy Regulatory Commission (BERC) sets retail electricity prices according to a rising block tariff scheme (Figure 2). There are two schedules for domestic users. The lifeline plan is predominantly used in rural areas. The tariff rates are the same for both pre-paid and post-paid customers.

Figure 2: Electricity tariff rates in Bangladesh from July 2017 to June 2018



In Bangladesh, pre-paid electricity metering was first implemented as a pilot project in some selected areas in Dhaka by BPDB in 2004 with a view to reducing non-technical electricity losses, maximising electricity bill collection, and better servicing customers. In mid-2011, five different utilities (BPDB, DESCO, DPDC, WZPDCL, and BREB) signed contracts and initiated a unified pre-paid metering programme to replace post-paid meters in selected areas in the major cities. Currently, three electricity DISCOMs—BPDB, DPDC, and DESCO—have replaced over 35% of their post-paid meters with pre-paid meters (Figure 3). The Bangladesh Rural Electrification Board (BREB), which serves the greatest number of customers, has only switched a small percentage of its customers to pre-paid metering.

Figure 3: Pre-paid meter installation in Bangladesh

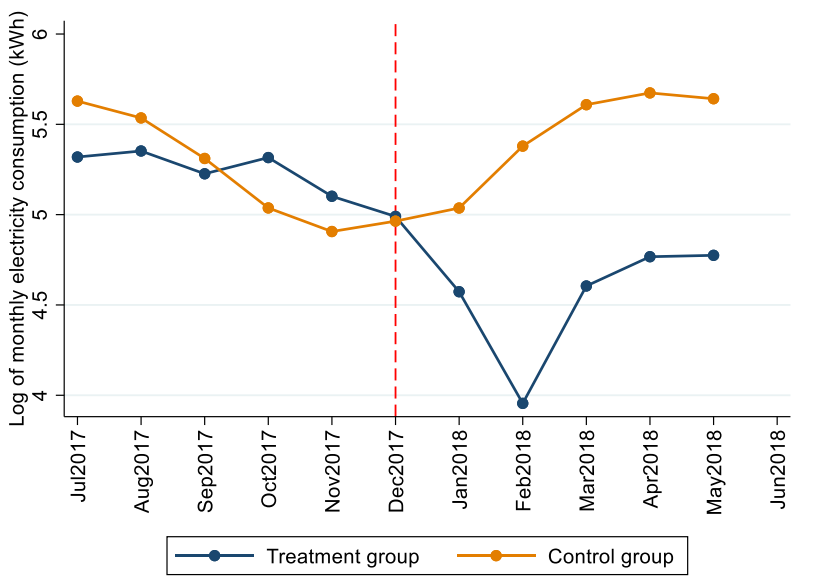


BREB: Bangladesh Rural Electrification Board; BPDB: Bangladesh Power Development Board; DPDC: Dhaka Power Distribution Company Ltd; WZPDCL: West-Zone Power Development Company Ltd; DESCO: Dhaka Electricity Supply Company Ltd. Source: based on data received from BERC and the electricity DISCOMs (BPDB, DESCO, DPDC, WZPDCL, BREB).

We obtained data from DPDC consisting of monthly electricity billing data for 7,954 customers from Ramna and Khilgaon from July 2017 to June 2018. Customers in Khilgaon were the treatment group, while customers in Ramna served as a control group.

Figure 4 presents the raw averages for each group in each month. The red dotted line represents the point in time when the treatment group was switched to pre-paid meters. Using difference-in-difference techniques that control for seasonal consumption patterns, we found that customers' monthly electricity consumption stepped down by 17% on average when they were switched from post-paid to pre-paid metering.

Figure 4: Effect of switching to pre-paid metering on electricity consumption in Dhaka



7 Conclusion

Our results from Bangladesh are similar to previous studies of the effect of pre-paid metering on household electricity use. Despite there being theoretically some mechanisms that increase electricity consumption following the introduction of pre-paid metering, the empirical evidence shows that electricity consumption declines. However, given that Martin (2014) found the reduction in consumption reduced over time, longer-term research in more controlled settings would be helpful. The relative importance of the different mechanisms that reduce consumption is less clear.

If customers pay the same average price per kWh of electricity before and after switching to pre-paid metering, we could argue that the switch is welfare enhancing even though customers reduce their use of electricity. Customers could choose to consume the same amount of electricity as they did before the switch and only buy credit once a month. On the other hand, if the mental pain of paying up-front is very significant and is an important driver of reducing use, then perhaps switching to pre-paid metering does not boost the wellbeing of customers. Nevertheless, Oseni (2015) found that customers in Nigeria were willing to pay to switch to pre-paid metering. Baptista (2015) reported positive attitudes to pre-paid metering from her fieldwork in Maputo, as did Jacome and Ray (2018) for Zanzibar. For these customers, avoiding surprise bills was of primary importance. Using pre-paid metering gave them control over their consumption.

Where utilities lose money serving retail customers, pre-paid metering can help their profitability (at least in the short term) by reducing generation and meter reading and billing costs. In the longer term, higher consumption might be needed to make serving retail customers more viable. Introducing pre-paid metering should result in a one-time reduction in consumption, but should not affect the long-term rate of growth with economic development.

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