



Electricity billing systems and household electricity use behaviour in Ibadan, Nigeria



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ABSTRACT

This paper examined the behaviour of households regarding electric energy use in lighting, clothes washing, ironing, refrigerating, cooking and boiling of water in relation to electricity billing systems in Ibadan. The rational choice theory, augmented by sociological and psychological theories, forms the theoretical basis for this study. The purposive sampling method was used to select five LGAs in Ibadan, where 500 households were randomly selected. Cross tabulation technique was adopted to analyse the objectives. Regarding the use of electricity for lighting, the result showed that the metered electricity consumers have better energy saving behaviour than the unmetered consumers, while the postpaid meter users have more of energy wasting behaviour compared to the prepaid meter users. For washing clothes and ironing, the result showed that the unmetered customers have more energy wasting behaviour compared to metered customers. Also regarding the behaviour about the use of electricity for washing clothes and ironing, the postpaid users are more energy wasting. Lastly, while the unmetered electricity consumers are more energy wasting in the use of electric cooker, it is the metered consumers that have energy wasting behaviour in the use of refrigerators.

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Introduction

Available statistics from Nigeria's Federal Minister of Power, Works and Housing website indicates that, at the highest peak, Nigeria generates 5074.7 MW of electricity as at April 2016. This is grossly inadequate for a population of 173.6 million, as the demand forecast for electric energy in the country is 12,800 MW. According to the World Development Indicators (WDI) 2016, the country's electric power consumption is 142 kW per capita, while South Africa with a third of Nigeria's population has 4603 kW per capita. Also, China with several multiples of Nigeria's population (1.35 billion), has 3762 kW per capita of electricity. The implication of these scenarios is that, while efforts to increase generation of electric power starts yielding the desired benefits, there is the need for efficient utilization of the available electric energy. This could be done through the three means of getting energy to the end users (production, transmission and distribution). This paper is concerned with the distribution of electric power to the users and the ways the available energy is utilized. Etiosa (2008) maintained that the small percentage of Nigerians that have access to electricity are wasting it. He added that government had focused almost entirely on power generation without attention on how energy is used.

Presently, electricity consumers in Nigeria can be broadly categorized into two: those without meters and those that have meters. The metered consumers are equally in two categories: post-paid meter users and pre-paid meter users. Therefore, three categories of energy users in Nigeria are: unmetered, prepaid and postpaid. Several efforts have been made to transform all electric users to pre-paid meter users. First, Nigerian Electricity Regulatory Commission (NERC) introduced

the pre-paid metering system to electricity consumers in 2005, however, only few electricity customers got the pre-paid meter. Also, after the unbundling of the Power Holding Company of Nigeria (PHCN), the 11 succeeding private distribution companies have been making efforts to ensure that all electricity consumers are provided with pre-paid meters. Despite these efforts, the unmetered electricity consumers in Nigeria are about half of the registered electricity users as at 2014 (Oseni, 2015). According to the Presidential Task Force on Power (2012), the proportion of the registered electricity users that are unmetered in Ibadan is 63%. The unmetered consumers are usually charged arbitrarily by electricity distribution companies. Such charge is against the ideal and global practice to charge unmetered customers based on the average consumption of all unmetered households in an area, which is often jettisoned by utility companies in Nigeria (Oseni, 2015).

The energy policy initiatives to roll-out smart meters across the country is with the intension of altering consumers energy use behaviour, with the ultimate aim of avoiding wastage and ensuring efficient use of energy. This is because, energy efficiency, especially in the household is influenced by the behaviour of the household members, among other factors (Wilhite et al., 1996). Drawing implications from the billing system therefore, enables the policy makers and energy users to identify energy-saving behaviour and energy-wasting behaviour (Ishak et al., 2012). Unmetered electricity consumers usually have unlimited consumption, the knowledge of which is capable of encouraging wastage. For instance, such consumers are not likely to switch of their bulbs, and other appliances even when they are not needed. It is a common practice to see electricity bulbs on in the afternoon in many places in Nigeria. The energy use behaviour of the metered electricity

consumers (pre-paid and post-paid) is likely to be different, as they are likely to be mindful of their consumption. The readings of some post-paid metered consumers are not taken regularly by the distribution companies. This could be as a result of laziness on the part of the electricity distribution companies' workers or schemes by electricity consumers. Some consumers are in habit of intentionally locating their meters out of the reach of the distribution companies' workers. The household energy use behaviour of the post-paid metered consumers, whose meter readings are not taken regularly is likely to be inefficient. On the other hand, since pre-paid meters are designed to ensure effective increase in end-user involvement and engagement in energy saving, the energy use behaviour of the pre-paid metered consumers is likely to be efficient.

This paper, therefore analyzed the household energy use behaviour of the registered electricity users in relation to the billing system they adopt. Energy use behaviour regarding lighting, clothes washing, ironing, freezing, cooking and making hot water will be considered. Studies around energy efficiency in Nigeria has been on energy and growth (Ebohon, 1996; Omotor, 2008; Olusegun, 2008; Odularo and Okonkwo, 2009; Osigwe and Arawomo, 2015), energy efficiency and cars (Arawomo and Osigwe, 2016) etc. Specifically, those on metering and energy efficiency are limited. The first set analyzed the adoption and willingness to adopt prepayment billing in Africa, they include: (Tewari and Shah, 2003; Mwaura, 2012; Oseni, 2015; Gans et al., 2013; Adenikinju and Olatokunbo, 2014; Chou and Yutami, 2014; Torriti, 2014; O'Sullivan et al., 2014). The other category of studies considered the relationship between electricity billing system and household consumption. The studies include: Xu et al. (2015), D'Oca et al. (2014) and Beckel et al. (2014). The present study differ from the previous as it considers the relationship between electricity billing system and household energy use behaviour in major electricity consuming gargets used for lighting, clothes washing, ironing, refrigerating, cooking and boiling of water in the households. Household energy use behaviour is often ignored or underestimated especially in relation to billing system. Moreover, Hori et al. (2013) maintained that whatever influence consumers' energy behaviour, they are unlikely to be uniform across counties, regions and cities. Empirical evidence from Nigeria, that has found it difficult to increase its electric generation, is desirable.

This paper is structured into five sections, the first provides the introduction. The second section reviewed the previous studies done on electricity billing system and energy used behaviour. Section three considered the theoretical framework and methodology. The empirical analysis was done in section four, while the conclusion made in the last section.

Literature review

This section provides the synthesis of the literature and its link with the investigation being pursued in this paper. The link between *electricity billing systems* and household energy use behaviour is a recent phenomenon, the evolvment of the literature is reviewed. The review of literature for this study will be handled in three sections: electricity billing system, household energy use behaviour and the link between the two.

Electricity billing system

Several studies have analyzed electricity billing system in Africa and other continents. For instance, Tewari and Shah (2003) assessed South African prepaid electricity experiment. The study reviewed the economics, logistics, and technology underlying the South African experiment of prepaid electricity. The paper attributed the success of the program to good marketing campaign, innovative tariff schedules, better planning and management, and so on. Mwaura (2012) also analyzed the adoption of electricity prepayment billing system to reduce non-technical energy losses in Uganda, drawing lessons from Rwanda. The paper assessed potential benefits of the Electricity Payment Billing System (EPBS) in reducing power theft; understanding how EPBS

operates and evaluating the possibility of EPBS adoption in Uganda. Findings indicated that for EPBS to be successfully adopted in Uganda, capital availability, proportion of EPBS targetable customers, energy use and revenue for those being targeted; and enforcement of a deterrent penalty for those apprehended stealing power are to be taken seriously. Oseni (2015) examined the willingness to adopt prepayment metering (PPM) for a sample of Nigerian households that were not prepayment users. The estimated results revealed that decisions to adopt a prepayment meter are significantly affected by current electricity spending, current billing method and the split incentive problem. Whereas current electricity spending significantly increased the tendency to adopt PPM, the split incentive problem reduced the probability of adoption. Although unmetered consumers were more likely to express a willingness to adopt a PPM system than post-paid customers, they did not intend to pay a significantly higher amount to obtain the prepayment service. Income did not play a significant role in decision-making concerning PPM adoption and the corresponding WTP amount.

Also, outside Africa, Gans et al. (2013) estimated the effect of real-time usage information on residential electricity consumption in Northern Ireland. They relied on this event that account for the endogeneity of price and payment plan with consumption through a plan selection correction term, and found that the provision of information is associated with a decline in electricity consumption of 11–17%. They also found that the reduction is robust to different specifications, selection-bias correction methods and subsamples of the original data. The advanced metering program delivers reasonably cost-effective reductions in carbon dioxide emissions, even under the most conservative usage reduction scenarios. Chou and Yutami (2014) analyzed smart meter adoption and deployment strategy for residential buildings in Indonesia. For countries pursuing sustainable development and energy efficiency, the use of smart meters is considered a first step in allowing residential consumers to remotely control their energy consumption, and a promising. The study enhanced the understanding of consumer perceptions and behaviours, and can help decision makers and energy utility companies develop policies and strategies for a “one-size-fits-all” program related to smart meter applications in future residential buildings.

Torriti (2014) compared the sustainability impacts of smart meters and load controllers in an occupied office building in Italy. Government initiatives in several developed and developing countries to roll-out smart meters call for research on the sustainability impacts of these devices. Findings showed that demand reductions associated with a smart meter device are 5.2% higher than demand reductions associated with the load controller. O'Sullivan et al. (2014) reported on a longitudinal interview study of consumers, who were either using prepayment metering or experiencing difficulty paying their electricity bills to explore how prepayment metering influences household budgeting and management of electricity use. The study highlighted that better regulation of the presently market-led electricity prepayment metering systems used in New Zealand could reduce the disadvantages while capturing the potential benefits of using prepayment metering for consumers.

Household energy use behaviour

Energy use behavioural models are commonly deliberated in economic psychology. In the context of energy consumption, the consumption of energy is not behaviour but rather it is the consequence of behaviour (Martiskainen, 2007). Such consequential behaviour include turning the lights off or lowering thermostat levels (Becker et al., 1981). Becker et al. (1981) analyzed the behaviour which relate to households' direct energy requirements (electricity and space heating), including behaviours such as turning lights on, using electric appliances, adjusting thermostat settings, cooking and washing. The study also briefly discusses sustainable consumption behaviours, which are closely linked to purchasing decisions such as the buying of energy efficient appliances.

Wilhite et al. (1996) compared and contrasted the results of ethnographic investigations of energy use behaviour in Fukuoka, Japan

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