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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.

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

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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 mater 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 wiliness 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 evolvement 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

and Oslo, Norway. These studies show significant differences in end use patterns for space heating, lighting and hot water use. They discussed how these patterns are related to cultural and economic factors. Their findings show that while energy intensive space heating and lighting habits have become an integral part of the presentation of the Norwegian home, Japanese space heat and light habits are more disciplined and less culturally significant. In Japan, the bathing routine is extremely important to the Japanese lifestyle and at the same time very energy intensive. Other energy intensive patterns are identified which do not have the same cultural significance, such as lax temperature setback in Norway and dish washing practices in Japan. The policy implications of these findings are discussed. Barnicoat and Danson (2015) analyzed the attitudes and behaviours of the ageing householders towards energy use in Scotland. Their behaviours regarding energy and technology use differ from the majority as they are usually living on low incomes and are at risk of fuel poverty. Their willingness and capacity to change time-use behaviours and reduce consumption is crucial. A study of older tenants in rural Scotland is presented. Sensors and IHDs were installed to measure and display electricity costs and consumption of large appliances and the electricity supply for each house, and show internal household and external temperatures. Householder's use of energy, habits and routine, strategies for keeping warm and attitudes towards technology, smart metering, IHDs and direct external control of appliances and heating were explored through interviews. Conclusions identify significant implications for future research and policy.

Linking electricity billing system and household energy use behaviour

Xu et al. (2015) analyzed a case study of smart meter and in-home display for residential behaviour change in Shanghai. The paper aimed to identify the effectiveness of smart meters and real-time IHDs in reducing Shanghai household energy consumption through a pilot investigation. The research results demonstrate the improved awareness, understanding, and attitudes towards the energy saving by smart meters and IHDs. Nachreiner et al. (2015) described the specific characteristics of household electricity consumption that should be taken into account. Also, a comprehensive psychological model of self-regulated behaviour change that covers the complete process by which new types of behaviour are chosen and implemented is described in detail and different behavioural stages and components crucial for the design of information strategies are identified. A detailed overview is given of different existing applications and which stages of change these affect. However, as none of these existing smart meters features comprehensive and combined informational strategies that systematically cater to consumers in all stages of behavioural change, it is concluded that further efforts to optimise and evaluate smart meters should be undertaken. A smart meter information system which is designed according to these insights is outlined.

D'Oca et al. (2014) assessed the effectiveness of smart monitoring system in reducing domestic electricity consumption. The paper tested 31 Italian families selected among volunteers all over Italy, participating to the first trial phase from October 2012 to November 2013. A combination of persuasive communication strategies such as graphical real-time and historical feedback based on real data and comparison tools to encourage competitiveness against "similar" households were provided to users through a domestic user-friendly interface. In addition, personalized energy saving prompts were sent via web-newsletters to trial users. The paper concluded that energy related persuasive communication is effective in reducing electricity consumption in dwellings on average −18% and up to −57%.

Beckel et al. (2014) evaluated a system that uses supervised machine learning techniques to automatically estimate specific "characteristics" of a household from its electricity consumption. The characteristics are related to a household's socio-economic status, its dwelling, or its appliance stock. They evaluated the smart meter data collected from 4232 households in Ireland at a 30 min granularity over a period of 1.5 years. The analysis showed that revealing characteristics from smart meter data is feasible, as the method achieves an accuracy of more than 70% over all households for many of the characteristics and even exceeds 80% for some of the characteristics. The findings are applicable to all smart metering systems without making changes to the measurement infrastructure. The inferred knowledge paves the way for targeted energy efficiency programs and other services that benefit from improved customer insights. On the basis of these promising results, the paper discusses the potential for utilities as well as policy and privacy implications.

Adenikinju and Olatokunbo (2014) analyzed the impact of billing methods on electricity consumption in Nigeria. The studies showed that a prepaid meter reduces electricity consumption. This study investigates the comparative advantage of the prepaid system over the conventional billing method using a survey technique to find out the preference of the households in Nigeria as a whole. Empirical evidence from the study shows that the adoption of the prepaid meter mechanism will reduce the electricity consumption of users. The study suggests the introduction and acceptance of the prepaid meter as a measure for the conservation of energy.

Theoretical framework and methodology

Theoretical framework

A number of theories have been used to analyze energy use behaviour. Some of such theories include: rational choice theory, theory of reasoned action, theory of planned behaviour, ecological value theory, value belief norm theory, attitude-behaviour model, theory of interpersonal behaviour, persuasion theory and social learning theory. It should be remarked that none of these theories can singlehandedly explain energy use behaviour. While the rational choice theory is economic others are sociological and psychological. The rational choice theory forms the basis for this study. The other sociological and psychological will be complementary. The rational choice theory is based on the notion that consumers weigh the expected costs and benefits of different actions and choose those actions which are most beneficial or least costly to them (Jackson, 2005). The theory is also based on the principle that in order to weigh the costs and benefits of various options, the consumer needs information on the possible actions or goods they can choose from in order to make rational choices (Becker, 1978; Bittle et al., 1979; Bittle et al., 1979–1980). The rational choice theory is very limited, however, as it fails to account the influence of factors such as habits, emotions, social norms, moral behaviour and cognitive limitations (Jackson, 2005), which was also shown by much of the earlier research with information only campaigns having little influence on people's behaviour.

Methodology

Sample and sample technique

The population for this study is Ibadan, the capital city of Oyo State, Nigeria and it is the third largest metropolitan city in the country, based on population, after Lagos and Kano. The population of the city is about 3 million according to the 2006 population census. Ibadan city has a total of eleven Local Governments Area (LGA). It consist of five urban LGA and six semi-urban LGAs. The multi-stage sampling technique was used to select the targeted respondents. First, the purposive sampling method was used to select the five urban LGAs in the city, they include Ibadan North, Ibadan North-East, Ibadan North-West, Ibadan South-East and Ibadan South-West. The selection of these LGAs was based on the higher concentration of registered electricity users that have meter in the areas, especially the pre-paid meters. Moreover, the random sampling technique was used to select 100 households in each of the LGA.

Statistical analysis

Cross-tabulation is the main technique adopted for this paper, considering the significance of the differences in household energy use

behaviour across the various electricity billing systems available in Ibadan. The use of cross tabulation in this paper brings out the differences in energy use behaviour of metered and unmetered electricity consumers. Also it empirically established the differences in energy use behaviour of pre-paid meter users and post-paid meter users.

Empirical analysis

This paper sought to examine the effects of billing system adopted by house units for the payment of electricity in Ibadan on their electricity use behaviour. The main concern is to ascertain whether the billing system each household adopt causes electricity energy saving behaviour or electricity energy wasting behaviour. This is done by analyzing the behaviour of households in relation to the metering system that is adopted. The analysis is done for the major electricity energy consuming gargets in the houses: lighting, clothes washing, ironing, cooking and refrigerating. We compared the behaviour of the metered consumers with that of unmetered consumers. Also, we compared energy use behaviour of customers using pre-paid meters with those using post-paid meters.

Lighting

The cross-tabulation of metering systems and the behaviour respondents in the use of bulbs for lighting is presented in Table 1. The result showed that the metered electricity consumers have better energy saving behaviour than the unmetered consumers regarding the use of electricity for lighting. Alternatively expressed, the unmetered consumers exhibits more energy wasting behaviour than the metered consumers. Precisely, larger proposition of unmetered electricity users (57.1%) use more than one electric bulbs in a room, compared to proportion of metered electricity users (26.6%). Similarly, more of the unmetered electricity users (71.4%) usually leave electric bulb on, while sleeping compared to metered consumers (27.4%). Concerning turning off of electric bulbs every morning, greater proportion of the metered consumers (86.6%) turns off electric bulbs compared to the unmetered consumers (28.5%). This implies that the metered consumers are more conscious of energy saving behaviour. For other purposes of lighting, greater share of the unmetered electricity customers use bulbs for decoration (89.3%) and heating (35.7%) compared to the metered consumers (13.3%) and (8.9%) respectively. This indicate that they do not mind they volume of electricity they consume at a point in time. The only case in which the metered electric customers use light more than the unmetered was for security light, while 72.5% of the metered customers use security light, only 67.9% of unmetered customers use security light. This could have been the relative importance placed in providing security in developing country.

The electricity use behaviour of prepaid and postpaid meter users regarding lighting were equally compared. The general result showed that the postpaid meter users have more of energy-wasting behaviour compared to the prepaid meter users regarding the use of electricity for lighting. This is not unexpected as the readings of meter of most of them are not taken regularly. Hence, they are likely to behave like the unmetered electricity users. This finding, that most postpaid users engages in energy wasting behaviour, is anchored on the fact that more of them (26.6%) use more than one bulb in a room compared to prepaid users (23.2%). Also, more of the prepaid meter users (100%) turn off all their bulbs regularly every morning as against only 40.8% of the postpaid electric users that turns theirs off. In addition, more of the postpaid meter customers use electric bulbs for decoration and heating compared to prepaid users.

Clothes washing and ironing

Clothes washing and ironing are other electric energy consuming items for households. The cross tabulation of metering systems and behaviour regarding washing and ironing are presented in Table 2. Similar to the use of electricity for providing lighting, the result showed that the unmetered customers are more energy wasting compared to metered customers concerning the use of electricity for washing clothes and ironing. For instance, higher proportion of the unmetered electricity consumers (57.1%) have washing machines in their houses as against 29% of the metered consumers that have.

Moreover, the unmetered consumers use their washing machine more often that the metered users, while the metered consumers give their clothes to dry cleaners more than the unmetered. The unmetered electric users can wash their clothes as many times as possible, over 57.6% of them use machine to wash clothes more than three times in a week, as against 11% of metered consumers. The energy use behaviour of the postpaid meter users is not different from that of unmetered electricity consumers, as their behaviour showed that they are more energy wasting compared with prepaid electricity users.

Cooking and refrigerating

Other gargets that consume electricity energy heavily in the households are electric cookers and refrigerators. Contained in Table 3 is the cross-tabulation of metering systems and the behaviour of households regarding the use of electric cooker and refrigerators. 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

Table 1
Cross-tabulation of metering systems with electricity use behaviour: lighting.

Behaviour regarding lightning		Do you have meter in your house?			What type of meter do you have?		
		Metered	Unmetered	Total	Pre-paid	Post-paid	Total
Do you use more than one bulb in any of the rooms in your house?	Yes	90 (26.6%)	80 (57.1%)	170 (35.6%)	47 (31.1%)	43 (23.2%)	90 (26.6%)
	No	247 (73.4%)	60 (42.9%)	307 (64.4%)	104 (68.6%)	143 (76.8%)	247 (73.4%)
	Total	337 (75.3%)	140 (24.6%)	477 (100%)	151 (44.8%)	186 (55.1%)	337 (100%)
Do you leave your bulbs on while you are sleeping	Yes	92 (27.4%)	100 (71.4%)	192 (40.3%)	5 (2.7%)	87 (57.2%)	92 (27.4%)
	No	245 (72.6%)	40 (28.6%)	285 (59.7%)	180 (97.3%)	65 (42.7%)	245 (72.6%)
	Total	337 (70.6%)	140 (29.4%)	477 (100%)	185 (54.8%)	152 (45.2)	337 (100%)
Do you turn off all your bulbs regularly every morning	Yes	292 (86.6%)	40 (28.5%)	332 (69.6%)	261 (100%)	31 (40.8%)	292 (86.6%)
	No	45 (13.3%)	100 (71.4%)	145 (30.3%)	0 (0%)	45 (59.2%)	45 (13.3%)
	Total	337 (70.6%)	140 (29.3%)	477 (100%)	261 (77.4%)	76 (22.6%)	337 (100%)
Apart from lighting, do you used bulb for security	Yes	245 (72.5%)	95 (67.9%)	340 (71.3%)	186 (89.4%)	58 (44.9%)	245 (72.5%)
	No	93 (27.5%)	45 (32.1%)	137 (28.7%)	22 (10.6%)	71 (55.1%)	93 (27.5%)
	Total	337 (70.6%)	140 (29.4%)	477 (100)	208 (61.7%)	129 (38.2%)	337 (100%)
Apart from lighting, do you used bulb for decoration	Yes	45 (13.3%)	125 (89.3%)	170 (35.6%)	6 (2.8%)	39 (30.2%)	45 (13.3%)
	No	293 (86.7%)	15 (10.7%)	307 (64.4%)	202 (97.2%)	90 (69.8%)	293 (86.7%)
	Total	337 (70.6%)	140 (29.3%)	477 (100)	208 (61.7%)	129 (38.3%)	337 (100%)
Apart from lighting, do you used bulb for heat/warmth during raining/harmatan seasons	Yes	30 (8.9%)	50 (35.7%)	80 (16.7%)	17 (7.8%)	13 (10.9%)	30 (8.9%)
	No	307 (91.1%)	90 (64.3%)	398 (83.3%)	201 (92.2%)	106 (89.1%)	307 (91.1%)
	Total	337 (70.6%)	140 (29.3%)	477 (100%)	218 (64.7%)	119 (35.3%)	337 (100%)

Table 2
Cross-tabulation of metering systems with electricity use behaviour: clothes washing and ironing.

Behaviour regarding washing		Do you have meter in your house?			What type of meter do you have?		
		Metered	Unmetered	Total	Pre-paid	Post-paid	Total
Do you have washing machine in your house	Yes	100 (29.6%)	80 (57.1%)	180 (37.7%)	80 (27.0%)	20 (48.7%)	100 (29.6%)
	No	237 (70.4%)	60 (42.9%)	298 (62.3%)	216 (73.0%)	21 (51.3%)	237 (70.3%)
	Total	337 (70.6%)	140 (29.3%)	477 (100%)	296 (87.8%)	41 (12.2%)	337 (100%)
How many times do you wash clothes every week?	1	48 (48.0%)	17 (21.2%)	65 (%)	21 (63.6%)	27 (57.4%)	48 (60%)
	2	21 (21.0%)	37 (46.2%)	58 (%)	12 (36.4%)	9 (19.1%)	21 (26.3%)
	3 and above	11 (11.0%)	46 (57.6%)	57 (%)	0 (0.0%)	11 (23.4%)	11 (13.8%)
	Total	80 (55.5%)	100 (44.4%)	180 (100%)	33 (41.3%)	47 (58.8%)	80 (100%)
Because of the metering system you adopt, do you give out your clothes to dry cleaners for washing?	Yes	100 (100%)	20 (25.0%)	120 (66.7%)	41 (100%)	59 (100%)	100 (100%)
	No	0 (0%)	60 (75.0%)	60 (33.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Total	100 (55.6%)	80 (44.4%)	180 (100%)	41 (41.0%)	59 (59.0%)	100 (%)
Because of the metering system you adopt, do you continue to wear your clothes even when they are dirty?	Yes	100 (100%)	80 (80%)	180 (%)	80 (100%)	20 (100%)	100 (100%)
	No	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Total	100 (55.6%)	80 (44.4%)	180 (100%)	80 (80.0%)	20 (20.0%)	100 (100%)
How many times do you iron clothes every week?	1	319 (94.6%)	92 (65.7%)	411 (86.2%)	301 (96.5%)	18 (72.0%)	319 (94.7%)
	2	18 (5.3%)	49 (34.3%)	67 (13.8%)	11 (3.5%)	7 (28.0%)	18 (5.3%)
	Total	337 (70.6%)	140 (29.4%)	477 (100%)	312 (92.6%)	25 (7.4%)	337 (100%)
Because of the metering system you adopt, do you give out your cloths to dry cleaners for ironing?	Yes	297 (93.1%)	81 (88.1%)	378 (91.9%)	198 (94.3%)	99 (90.8%)	297 (93.1%)
	No	22 (6.9%)	11 (11.9%)	33 (8.1%)	12 (5.7%)	10 (9.2%)	22 (6.9%)
	Total	319 (77.6%)	92 (22.4%)	411 (100%)	210 (65.8%)	109 (34.2%)	319 (100%)
Because of the metering system you adopt, do you wear your clothes even when they are not ironed?	Yes	191 (59.9%)	8 (86.9%)	199 (48.4%)	162 (61.4%)	29 (52.7%)	191 (59.9%)
	No	128 (40.1%)	84 (9.1%)	212 (51.6%)	102 (38.6%)	26 (47.3%)	128 (40.1%)
	Total	319 (77.6%)	92 (22.9%)	411 (100%)	164 (82.8%)	55 (17.2%)	319 (100%)

refrigerators. Putting it into context, although more of the metered consumers (54.3%) have electric cooker in their homes, more of the unmetered consumers (85.3%) use their electric cooker all the time. About 90.6% of the unmetered consumers claimed that based on the billing system they use, they will always use electric cooker to boil water every morning.

Concerning the use of refrigerators, more of the metered consumers (62.3%) have freezers or fridges in their houses, as against 36.4% of the unmetered users. As against other gadgets, higher proportion of the meter consumers (88.1%) use their refrigerators all the time compared with the metered consumers (60.8%). The postpaid meters are also found to have energy wasting behaviour more than prepaid electricity users.

Conclusion and recommendation

Household energy use behaviour is often ignored or underestimated especially in relation to billing system. The relationship between electricity billing systems and household energy use behaviour of the registered electricity users in Ibadan was analyzed. The paper specifically examined the behaviour of households regarding energy use in lighting, clothes washing, ironing, fridge, cooking and hot water. The rational choice theory forms the basis for this study. The other sociological and psychological, such as theory of reasoned action, theory of planned behaviour, value belief norm theory, attitude-behaviour model will be complementary. The purposive sampling method was used to select the five urban LGAs in the city, they include Ibadan North, Ibadan North-East, Ibadan North-West, Ibadan South-East and Ibadan South-West. The selection of these LGAs was based on the higher concentration of registered electricity users Moreover, the random sampling technique was used to select 100 households in each of the LGA, making a total of 500 respondents. Cross tabulation technique was adopted for this paper.

The result showed that the metered electricity consumers have better energy saving behaviour than the unmetered consumers regarding the use of electricity for lighting. Also, the result showed that the postpaid meter users have more of energy wasting behaviour compared to the prepaid meter users regarding the use of electricity for lighting. 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. 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.

Table 3
Cross-tabulation of metering systems with electricity use behaviour: cooking and refrigerating.

Behaviour regarding washing		Do you have meter in your house?			What type of meter do you have?		
		Metered	Unmetered	Total	Pre-paid	Post-paid	Total
Do you have electric cooker/stove in your house?	Yes	183 (54.3%)	34 (24.3%)	217 (45.5%)	93 (61.6%)	90 (48.4%)	183 (54.3%)
	No	154 (45.7%)	106 (75.5%)	260 (54.5%)	58 (38.4%)	96 (51.6%)	154 (45.7%)
	Total	337 (70.6%)	140 (29.4%)	447 (100%)	151 (44.8%)	186 (55.2%)	337 (%)
How often do you use your electric cooker?	All the time	16 (8.7%)	29 (85.3%)	45 (20.7%)	6 (4.5%)	10 (20.4%)	16 (8.7%)
	Occasionally	10 (5.5%)	3 (8.8%)	13 (6.0%)	7 (5.2%)	3 (6.1%)	10 (5.5%)
	Not at all	157 (85.8%)	2 (5.9%)	159 (73.3%)	121 (90.3%)	36 (73.5%)	157 (85.8%)
	Total	183 (84.3%)	34 (15.7%)	217 (100%)	134 (73.2%)	49 (26.8%)	183 (100%)
Irrespective of electricity billing system, I use electric cooker to boil water every morning?	Yes	16 (61.5%)	29 (90.6%)	45 (77.6%)	6 (46.2%)	10 (76.9%)	16 (61.5%)
	No	10 (38.5%)	3 (9.4%)	13 (22.4%)	7 (53.8%)	3 (23.1%)	10 (38.5%)
	Total	26 (44.8%)	32 (55.2%)	58 (100%)	13 (50.0%)	13 (50.0%)	26 (100%)
Do you have freezer/fridge in your house?	Yes	210 (62.3%)	51 (36.4%)	261 (54.7%)	32 (26.9%)	178 (95.7%)	210 (62.3%)
	No	127 (37.7%)	89 (63.6%)	216 (45.3%)	119 (78.8%)	8 (4.3%)	127 (37.7%)
	Total	337 (70.6%)	140 (29.4%)	477 (100%)	151 (44.8%)	186 (55.2%)	337 (100%)
How often do you use your freezer/fridge?	All the time	185 (88.1%)	31 (60.8%)	216 (82.8%)	149 (90.3%)	36 (80.0%)	185 (88.1%)
	Occasionally	21 (10.0%)	17 (33.3%)	38 (14.6%)	14 (8.5%)	7 (15.6%)	21 (10.0%)
	Not at all	4 (1.9%)	3 (5.9%)	7 (2.7%)	2 (1.2%)	2 (4.4%)	4 (1.9%)
	Total	210 (80.5%)	51 (19.5%)	261 (100%)	165 (78.6%)	45 (21.4%)	210 (100%)

Based on these results, the following recommendations are offered:

- The prepaid billing system is found to be most effective means of conserving electricity energy in Ibadan, the available 5074.7 MW of electricity in Nigeria can be put to better use if all houses use prepaid meters.
- Pending the time that all houses we get the prepaid meters, regulations should be made concerning the use of electricity.
- The distribution companies could set up monitoring taskforce to ensure that unused gargets are put off, especially security lights.
- Efforts should be made to ensure that households use energy efficient gargets.
- It is recommended that prepaid meters be distributed to houses on credits and deductions be made on monthly basis.
- Government may need to subsidies the production and distribution of prepaid meters to houses to ensure efficient use of available electricity energy.

Appendix A. Questionnaire

I am a Research Fellow in *Nigerian Institute of Social and Economic Research (NISER),* conducting a research on "***Electricity Billing* Systems and *Household Energy Use Behaviour*?**" I solicit that you participate in this research by completing this questionnaire. Information provided will be accorded the confidentiality required and used for research purpose only.

Thank you sir/ma.

Section 1: Household and Dwelling Characteristics

1. The highest educational qualification of the household head is …… (a) No education (b) Primary education (c) Secondary Education (d) Islamic Education (e) Tertiary Education
2. Household income …… (a) ₦10,000 – ₦50,000 (b) ₦51,000 - ₦100,000 (c) ₦101,000 - ₦150,000 (d) ₦151,000 – ₦200,000 (e) ₦200,000 above
3. Household size (number of people in the family)..... (a) 1 (b) 2 (c) 3 (d) 4 (e) 5 and above
4. What is the type of building you reside in …… (a) B-Q (b) Face me (c) Flat (d) Duplex
5. The building being occupied is …… (a) Owned by the head of the household (b) A rented apartment
6. How many rooms are in the house? (a) 1 (b) 2 (c) 3 (d) 4 (e) 5 and above

Section 2: Electricity Billing System

1. Do you have meter in your house?..... (a) Yes (b) No
2. If your response to question "1" is "No", how much is the average electricity bill in a month? …… (a) ₦500 – ₦1,500 (b) ₦1,501 - ₦2,500 (c) ₦2501 - ₦3,500 (d) ₦3501 - ₦4,500 (e) ₦4501 - ₦5,500 (f) above ₦5,500
3. If your house has meter, what type of meter do you have? (a) Pre-paid (b) Post-paid
4. If your response to question (3) is post-paid, which of the actions of the IBEDC is applicable to you?(a) never take your reading (b) takes your readings occasionally (c) takes your readings regularly
5. If you use post-paid meter, what is your average electricity bill in a month …… (a) ₦500 – ₦1,500 (b) ₦1,501 - ₦2,500 (c) ₦2501 - ₦3,500 (d) ₦3501 - ₦4,500 (e) ₦4501 - ₦5,500 (f) above ₦5,500
6. If your response to question (3) is pre-paid, what is your average electricity bill in a month?…… (a) ₦500 – ₦1,500 (b) ₦1,501 - ₦2,500 (c) ₦2501 - ₦3,500 (d) ₦3501 - ₦4,500 (e) ₦4501 - ₦5,500 (f) above ₦5,500
7. Are there in-house regulations guiding the use of electricity in your house? (a) Yes (b) No
8. If your response to question "7" is "Yes", list some of the regulations:

……..
……..
……..
……..

Section 3: Lighting

1. Are you aware that some bulbs are energy saver? (a) Yes (b) No
2. Do you use energy saving bulbs in your house? (a) Yes (b) No
3. Do you use more than one bulb in any of the rooms in your house? (a) Yes (b) No
4. Do you leave your bulbs on while you are sleeping? (a) Yes (b) No
5. Do you turn off all your bulbs regularly every morning? (a) Yes (b) No
6. Apart from lighting, do you used bulb for security? (a) Yes (b) No
7. Apart from lighting, do you used bulb for decoration? (a) Yes (b) No
8. Apart from lighting, do you used bulb for heat/warmth during raining/harmatan seasons? (a) Yes (b) No

Section 4: Clothes Washing

1. Do you have washing machine in your house? (a) Yes (b) No
2. How many times do you wash clothes every week? ……..
3. Because of the metering system you adopt, do you give out your clothes to dry cleaners for washing? ……..…… (a) Yes (b) No
4. Because of the metering system you adopt, do you continue to wear your clothes even when they are dirty? ……. (a) Yes (b) No

Section 5: Ironing

1. Do you have iron in your house? ……. (a) Yes (b) No
2. How many times do you iron clothes every week? (a) 1 (b) 2 (c) 3 (d) 4 (e) 5 and above
3. Because of the metering system you adopt, do you give out your cloths to dry cleaners for ironing? ……..…… (a) Yes (b) No
4. Because of the metering system you adopt, do you wear your clothes even when they are not ironed?……. (a) Yes (b) No

Section 6: Cooking

1. Do you have electric cooker/stove in your house? ……..… (a) Yes (b) No
2. How often do you use your electric cooker? …… …… (a) All the time (b) Occasionally (c) Don't use it at all.
3. Although, using electricity to cook is costlier than kerosene stove and gas, I prefer electric stove because of my status …… (a) Yes (b) No
4. Irrespective of electricity billing system, I use electric cooker to boil water every morning? …….. (a) Yes (b) No

Section 6: Refrigerating

1. Do you have freezer/fridge in your house? ……..… (a) Yes (b) No
2. How many freezer/fridge do you use in your household? (a) 1 (b) 2 (c) 3 (d) 4
3. How often do you use your freezer/fridge? …… …… (a) All the time (b) Occasionally (c) Don't use it at all.
4. Irrespective of electricity billing system, I use every time? …….. (a) Yes (b) No

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