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EFFECT OF PREPAID METERS ON THE HOUSEHOLD EXPENDITURE ON ELECTRICITY CONSUMPTION IN ONDO STATE[1]

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Abstract: *Unfair high electricity billing is a challenge to consumers in Nigerian electricity market and it exerts undue pressure on households who are Charged for electricity service that are not supplied by service providers through estimated billing. Customers loss income as a result of this problem. Whether the introduction of prepaid meter will bring succor to consumers is an empirical issue. The hypothesis that adoption of prepaid meter reduces household expenditure on electricity consumption was tested in this study. A total of 577 (362 males and 215 females) participants were drawn from 4 local governments area of Ondo State using multistage sampling techniques. The participants had a mean age of 46.93 years and standard deviation of 21.04 years. The study was analyzed using frequency count, means and percentages. Results showed that 70.72% of the participants witnessed a reduction in their electricity expenditures as a result of adoption of prepaid meter plan which was attributed to elimination of estimated bills and users embracing electricity conservative strategies. More so, about 82% of the participants expressed their preference for prepayment electricity plan over old metering system. The implications of the finding is that the distribution companies should make more prepaid meters available as there is willingness on the part of electricity subscribers to buy into the metering plan.*

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Introduction

Electric power is a critical infrastructure for sustainable economic growth and development. This is because most economic activities are dependent on affordable and adequate energy for effective operation. Electricity is crucial to reducing the cost of doing business, enhancing productivity and quality of life. The inadequate provision of power has a pervasive impact on socio-economic activities and consequently the living standard of citizens in Nigeria. Most of the nation's infrastructure in the power sector in Nigeria was built in the 1970s and 1980s. In spite of these early efforts in the nation, the country has suffered significantly from the impact of epileptic and limited electricity supply, which has been attributed to poor maintenance culture of national infrastructure and poor expansion plan of the facilities (Ologundudu, 2014; Ibiene, Clinton and Chinago, 2018). In spite of abundant primary electricity resources - coal, natural gas, geothermal, tide, solar, biogas, biomas; and the huge Government investments in the sector over the last ten years, electricity supply remains a serious challenge to Nigeria's socio-economic development. Available statistics show that electricity generation in Nigeria was at its peak of 5375MW in February 2019 (AEP, 2020). This is grossly inadequate for a nation with population of over 200 million (Statista, 2020).
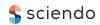
The narrative is the same for Ondo State, as both household and business are under the weight of epileptic power supply, which has paralysed economic activities. The federal government started a total restructuring of the power sector in 1999, with aim of providing reliable and quality electricity that is affordable, in a way that the small entrepreneur, the urban poor and rural dwellers will be able to have power at the flick of the switch. Substantial attempts were made by the federal government to establish more power plants in order to increase the low capacity being generated and such effort include Omotosho power station phase I and II located in Okitipupa Local Government Area. Despite several billion of naira invested in power generation, many household do not have access to electricity. Even, when electricity distribution makes available few hour of use of electric service, customers are exploited through arbitrary billing system for service not rendered. The introduction of pre-paid meter is believed to be a panacea to the instutionalized estimated billing system by service provider, but whether the same pre-paid metering system will help household optimized electricity usage and expenditure, remains an empirical issue.

Studies on metering and electricity consumption are limited. For instance, some studies examined the adoption and wiliness to adopt pre-paid billing system in Africa among which are; Mwaura (2013), Ofonyelu & Eguabor (2014) O'Sullivan et al., (2014) and Oseni (2015). Other studies investigated the nexus between electricity billing plan and household consumption (Oladimeji, 2005; Arawomo, 2017). Using basic economic theory, Qiu, Xing & Wang (2017) posits that there are four channels through which adoption of a pre-paid meter plan aids reduction in electricity consumption expenditure: nudging, price effects, information provision, and costs of being disconnected.

Prepaid systems is beneficial to both energy users and service providers. The plan gives customers better control of energy costs as users are more careful about their energy consumption, helps in household budgeting, eliminates the cost of disconnections and subsequently, leads to an increase in welfare (Tewari and Shah, 2003; Casarin and Nicollier (2009); Anderson et al,2012; Miyogo et al., 2013; O'Sullivan et al., 2014). The benefits of pre-paid meter plan to the electricity distribution companies are reduction of energy lost through theft resulted from illegal connections, reduction of fraud or non-payment of bills, and reduced financial risks from accumulated bills (Ogujor and Otasowie, 2010; Mwaura, 2013).

The present study differs from the previous as it tested the hypothesis of whether introduction of prepaid meters in Nigerian electricity market reduces household electricity expenditure. Recently, with the rapidly rising cost of electricity, some households will experience disconnections from electricity services for non-payment of bills or arising from over billing due to estimated billing method of the electricity providers. As a result, this study examined the effect of pre-paid meters on household electricity expenditure.

In Nigeria, electricity consumers fall under three categories: those that are not metered, those that have prepaid meters and subscribers with post-paid meter. Large number of electricity subscribers are unmetered. This problem is as old as the electricity market itself in Nigeria, even under the management of Nigerian Electric Power

Authority (NEPA), as public utility. The challenges of metering was subsequently transferred to the 11 electricity distribution companies that acquired the distribution sub-sector of the unbundled NEPA. Following the consumer outcry about high estimated billings of electricity distribution companies (DISCOs), Nigerian Electricity Regulatory Commission (NERC) introduced the pre-paid metering system to electricity consumers in 2005. However, every efforts to transform all electricity users to pre-paid meter have yielded little results, only small percentage of Nigerian households are on pre-paid plan (Oseni, 2015).

Benin Electricity Distribution Company (BEDC), one of the 11 distribution companies, has a market share that covers 4 states (Edo, Delta, Ondo and Ekiti). According to Fagbohun and Femi-Jemilohun (2017), BEDC is to distribute electric power to 77 Local Governments with 1500 rural communities, Households of 4.6 million, population of 13.2 million and it get only 9 percent of the total available power in Nigeria. With this low supply of electricity, emphasis should be on energy efficiency so as to make best use of the available electric power. However, evidence shows that even the small proportion of Nigerian households that have access to electricity are wasting it by way of not imbibing energy saving habit (Etiosa, 2008). Households that are not metered usually have access to unlimited power consumption, thus they have more tendency to indulge in electricity wastage such as switching on their bulbs during the day and appliances even when they are not needed among others. On the other hand, households that have pre-paid meters are more energy efficient and likely to engage in energy saving behaviour in order to reduce service charges.

This paper is structured into four sections, the first provided the introduction. The second section considered data and methods. The empirical analysis was done in section three while the concluding remarks was made in the last section.

Data and methods

Study area

This study was carried out in Ondo State of Western Nigeria with a land area of 14,793 square kilometers (sq.km) and population of 3.44 million according to 2006 national population census (National Population Commission, 2006). The favourable climate accounts for why over 80% of the inhabitants are farmers out of which majority are predominantly cocoa farmers. The tropical climate of the state is mainly of two seasons; rainy season and dry season. The temperature ranges between 21°C and 29°C and humidity is relatively high. The state is divided into 18 Local Government Areas (LGAs) for administrative convenience and, it is bounded in the North by Ekiti and Kogi States and in the South by the Atlantic Ocean. The farmers in the area grow cash crops such as cocoa kolanut, palm tree, coffee and food crops such as yams, maize, cocoyam etc. mostly at subsistence level.

Sources of data

The study made use of both primary and secondary data. The household micro data use in this study and was collected through a household expenditure survey that was conducted in the sampled areas with the use of questionnaires and interviews. The target respondents were heads of households.

Sampling procedure

The study was conducted in Ondo State using four Local Government Areas selected from the two senatorial districts that have access to national grid, as sampled areas. Primary data was obtained in a cross-section survey of selected households drawn by a combination of a multi-stage sampling techniques. The sample frame covers the list of towns constructed in selected 4 local government areas, 16 electoral wards;

  i. Akoko South East LGA: Ifira, Ipesi, Ipe and Isua I wards were selected out of 10 electoral Wards.
  ii. Akoko South West LGA: Oka I, Supare I, Akungba I and Oba I wards were selected out of 15 electoral Wards.
  iii. Akure South LGA: Aponmu, Gbogi/Isikan I, Ijomu/Obanla and Owode Imuagun wards were selected out of 11 electoral Wards.
  iv. Ondo East LGA: Bolorunduro, Fagbo, Oboto and Owena Bridge wards were selected out of 10 electoral Wards.

Sampling Size

The study constructs a 95% confidence interval with a Margin of Error of about ± 4% to determine an optimal sample size for population of the two senatorial district of Ondo State. The study, therefore, shall adopt a sample size of 600 (Krejcie & Morgan 1970).

Procedure for Administering Questionnaire

For the purpose of the study, questionnaires will be administered to the family head, in the 16 political wards drawn from these Local Government Areas; North (Akoko South East & Akoko South West) and Central (Akure South & Ondo East). In administering the questionnaire, the convenient sampling techniques shall be used.
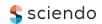
Results and discussion

Socio-Economic and Demographic Characteristics

Table 1. Distribution of Respondents by Socio-Economic Characteristics

	Frequency	Percentage (%)
Sex		
Male	362	62.8
Female	215	37.2
Age Range		
Below 30	89	15
30 – 40	188	33
41 – 50	135	23
Above 50	165	29
Marital Status		
Married	408	71
Single	126	22
Widow	24	4
Divorced/Separated	14	3
Education		
Below NCE	293	51
NCE	68	12
HND	46	8
B.Sc/B.Ed	138	24
Postgraduate	31	3
Religious Affiliation		
Christian	523	91.0
Muslim	43	7.5
Traditional	6	1.1
Others	2	0.4
Occupation		
Teaching	94	19.7
Civil Service	45	9.4
Public Service	12	2.5
Artisan	66	13.8
Farming	90	18.8
Others	171	35.8
Household Monthly Income		
Less than 20,000	116	24.5
20,001 – 40,000	131	27.7
40,001 – 60,000	80	17.0
60,001 – 80,000	64	13.5
80,001 – 100,000	48	10.2
100,0001 and above	30	6.3

Sources: Authors' computations.

Table 1 shows the socio-economic characteristics of respondents. The study observed that there were more males (62.8%) than females (38.2%). The age distribution of the respondents shows that fifty-two percent of the family heads were above 40 years of age. By grouping; 15.0% fell below 30 years, 33% were between 30 and 40 years, 23% were 41 to 50 and 29% were above 50 years. The marital status of respondents showed that 71% were

married, 22% were single while 4 % were widow. Three percent (3%) of the respondents were either divorced or separated. The distribution of the respondents by their level of education shows that more than half of the respondents (51%) comprises of people without formal education, primary school certificate holders, Secondary education and national diploma degree holders. Three percent (3%) of the respondents have post graduate degree, twenty-four percent (24%) are B.sc/B.Ed. degree holders, HND (8%) and NCE holders (12%).

On the religious affiliations of respondents, findings showed that 91% were Christians, 7.5% were Muslims, 1.1% were practicing traditional religion while 0.4% of the respondents fell in other religion category. More so, 19.7% of the respondents were teachers, civil and public servants were 11.9%, Artisan and Farming occupational distribution were 32.6% while others category were 35.8%. The distribution of income among the respondents in the study shows that majority (52.2%) of the family heads earned N40,000 or less per month, 30.5% have monthly income range of between N40,000 and N80,000 while 16.5% have monthly income of N80,000 and above. Inference from Table 1 on income distribution suggests that about 25% of the household lived below the poverty line of $1.90 per day (World Bank, 2017).

Table 2. Meter Coverage before the Introduction of Pre-Paid Meter

LGA	Number of Household	Percentage of Respondents (%)
Akoko South East	68	48.57
Akoko South West	74	52.86
Akure South	46	32.86
Ondo East	22	15.71
Average	**52.5**	**37.5**

Sources: Authors' computations.

Tables 2 and 3 show the distributions of household that were metered before the introduction of prepaid meter and the percentage of household that have prepaid meters in their residences. On the average, data presented in Table 2 suggests that about 38% of households in the study areas have electricity meter installed in their residences. It can also be inferred that more than half of these meters are in the Northern Senatorial district of the state (Akoko South East and Akoko South West LGAs). The households in Ondo East have the lowest distribution of meters before the introduction of prepaid meters in 2005.

Table 3. Distribution of Households with Pre-Paid Meters by LGA

LGA	Number of Household	Percentage of Respondents (%)
Akoko South East	10	7.14
Akoko South West	11	7.86
Akure South	23	16.43
Ondo East	22	15.71
Average	**16.5**	**11.79**

Sources: Authors' computations.

Table 3 shows that 15 years after introduction of prepaid meters to Nigeria electricity market, the distribution of households with installed prepaid meters are low, just about 12% on average. Akure South has the highest number of households with prepaid meters (16.43%). This might not be unconnected with the fact that Akure South is the state headquarters and a metropolitan city. However, prepaid meter coverage of about 17% is abysmally low. Similarly, Ondo East LGA that is close in proximity to the state capital and have 15.71% of prepaid meter coverage, it indeed mirrored the data the describe Akure South LGA. The data in Table 3 further shows that Akoko South West and Akoko South East LGAs that had high installation of analog and digital meter type under postpaid plan, have 7.86 and 7.14 respectively.

Table 4. Distribution of Monthly bills under old Meter System in Percentage

LGA	Average of N2,000	Between N2000-N5,000	Above N5,000
Akoko South East	18.92	78.38	2.70
Akoko South West	30.77	62.82	6.41
Akure South	16.13	45.16	38.71
Ondo East	12.9	54.84	32.26
Average	**19.68**	**60.3**	**20.02**

Sources: Authors' computations.

Table 4 captures the distribution of monthly bills that household received from the distribution company (in case of Ondo state it is Benin Distribution Company, BEDC). On the average, about 20% of the households in the study areas pay amount in neighborhood of N2,000 as electricity bills monthly, 60.3% pay between N2,000 and N5,000 and the rest of the households are charged N5,000 or more. The study found that 78.38% of the household in Akoko South East and 62.82% of the household in Akoko South West have bills that range from N2,000 to N5,000. These local governments comprises of communities that are majorly rural settlements, whose electricity use is no more than 50kWhr (R1 classification). According to Nigerian Electricity Regulatory Commission (NERC), all R1 customers are to be billed at N4/kWhr and a maximum of N200 per month by the distribution companies (NERC, 2020). As observed, in Table 3, these local government areas have low access to prepaid meters, hence, they are more prone to the problem of estimated bills otherwise called 'crazy' bills. Although the challenge of over-billing is not limited to rural and semi-urban area, it is actually a systemic problem that needs to be arrested by DISCOs.

Table 5. Percentage of Households that spend less on Electricity Consumption with introduction of Paid Meters

LGA	Percentage of Respondents (%)
Akoko South East	50.0
Akoko South West	70.0
Akure South	94.7
Ondo East	68.18
Average	**70.72**

Sources: Authors' computations.

Table 5 presented the percentage of households that spend less on electricity as a result of adoption of prepaid meter plan. Specifically, 50% of households in Akoko South East and 70% of households in Akoko South West experienced reductions in their electricity expenditure. The percentage of the households that witnessed a fall in electricity expenditures is higher in Akure South at 94.7% while at 68.18% in Ondo East.
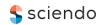
Evidence shows that there are two main factors that explain this reduction in electricity expenditures. They are consumption and billing issues. For consumption issues, many of the household that are under prepaid meter plan embrace conservative electricity use; as a result, households were able to control consumption of electric power and subsequently, the amount spent on electricity. More so, it is found that with introduction of the prepaid electricity meters, there is shift from using electrical appliances for some household activities such as cooking to the use of charcoal, firewood and cooking gas. This is consistence with the findings of Malama, Mudenda, Ng'ombe, Makashini and Abanda (2014). The other factor has to do with billing system. Most residences, especially the unmetered, are charged high electricity bills that are not reflective of electric power usage. This amount to exploitation of electricity users by the DISCOs. Hence, the electricity users subscribes quickly to the prepaid plan so as to escape from 'crazy bills' of distribution companies and start paying bills that are based on actual consumption rather than estimated bills.

Table 6. Household Preference for Pre-Paid Meters

LGA	Percentage of Respondents that prefer Pre-paid Meter to Old Metering System (%)
Akoko South East	68.3
Akoko Souh West	77.97
Akure South	94.94
Ondo East	84.44
Average	**81.41**

Sources: Authors' computations.

Table 6 showed the household preference for prepaid meters. The data suggest that about 82% of households on average preferred prepaid meter to the old metering system, although it was 70.72% that witnessed fall in electricity spending due to adoption of prepaid meters plan. One plausible explanation for the observed behavior of about 19% households that preferred old metering system is the exposure to cheat and fraud. Such households

prefer an arrangement that made it possible to bribe DISCOs officials instead of paying for electric power used. This type of behavior constitute great loss of revenue to the electricity distribution companies.

Conclusion

This study tested the hypothesis that adoption of prepaid meter reduces household expenditure on electricity consumption in Ondo State using a total of 577 participants were drawn from 4 local governments area of Ondo State using multistage sampling techniques. The findings of the study showed that 70.72% of the participants have a fall their electricity expenditures as a result of adoption of prepaid meter plan which was attributed to elimination of estimated bills and users embracing electricity conservative strategies. Also, many of the participants (about 82%) expressed their preference for prepayment electricity plan over old metering system. These findings are consistence with other studies such as Miyogo et al. (2013), O'Sullivan et al. (2014), Arawomo (2017) and Fagbohun and Femi-Jemilohun (2017).

In spite of evident benefits of prepaid meter plan to electricity utility providers and users, there is a major challenge that hampers the availability and mass installation of prepaid meters in users' premises. The initial capital outlay required to make prepaid meter available to consumers is huge and DISCOs often complain of insufficient fund to provide needed infrastructures. More so, the cost of purchase of prepaid meter that is passed on to electricity users is exorbitant. This discourages those who want to switch from old post-paid meters to prepaid meter. The implications of the finding is that the distribution companies should make more prepaid meters available as there is willingness on the part of electricity subscribers to buy into the metering plan. More so, the policy maker should remove the legal barrier to importation of prepaid meter in order to allow investors participate in importation and installations of prepaid meter.

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Appendix

Please read this document carefully. Your signature is required for participation. You must be at least 18 years of age to give consent to participate in this research.
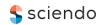
Dear Respondent,

This is a research project on electricity expenditures pattern in rural and urban households of Ondo State, Nigeria: Implication for poverty reduction strategies conducted by Modupe Fasoranti at Adekunle Ajasin University, Akungba-Akoko, Ondo State, Nigeria. You are invited to take part in this research project because you meet the criteria for participating in this study and you are 18 years old or above. Part of this research requires your responses on the attached questionnaire. It should take you an estimated about 10 minutes to complete the entire questionnaire. Feedback in the form of a one-page summary sheet will be available on request

Instructions: Please use a pen/pencil to complete the questionnaire.

Section A

This section of the questionnaire refers to demographic or biographical information. This information will allow us to compare groups of respondents. Kindly write in and tick the appropriate box.

1.	**Name of Community/Town**		
2.	**Gender**	Male	
		Female	
3.	**Age (in complete Years)**		
4.	**Marital Status**	Married	
		Single	
		Widow	
		Divorced/Separated	
5.	**Highest Educational Qualification**	No Education	
		Primary School Level	
		Secondary School Certificate	
		Teacher Training Certificate	
		National College of Education Certificate	
		Ordinary National Diploma	
		Higher National Diploma	
		B.Sc., B.A., B.Edu., B. Tech., B.A in (B.L.) or LL.B.	
		Post-Graduate Degree	

Section A (cont.)

6.	**Religious Affiliation**	Christian	
		Muslim	
		Traditional	
		Others	
7.	**Household Size** *(Number of household members living in a family)*		
8.	**House Type** *(Number of rooms space occupied by household)*		
9.	Occupation	Teaching	
		Civil Service	
		Public Service	
		Artisans	
		Farming	
		others	

Section B

This section of the questionnaire refers information on electricity consumption for cooling, cooking, lighting among other usage.

1. Do you have electric stove or electric cooker?   YES [   ]   NO [   ]

2. Please tick the correct response using the response options on the right side of the paper stated as: **Not at all= 0, A little = 1, Quite a bit = 2 and Extremely = 3**.

	0	1	2	3
If yes to (1) above, how often do you use electricity for cooking?				
Do you use electricity for boiling water?				

3. Do you use ceiling fans in your house for cooling or air conditioners?

   Ceiling Fans [   ]   Air Conditioners [   ]

Section C

This section of the questionnaire refers information on energy prices and alternative energy sources for cooling, cooking, lighting and for other uses. (Tick appropriately)

1. Which of these energies do you use as alternative to electricity for cooking?

Bottled gas (LPG)	Kerosene	Firewood

2. What was last price you paid for any of these?

Bottled Gas (per 12.5kg)	Kerosene (per gallon)	Firewood ( )

3. What type of coping mechanism you are using against irregular electricity supply?

	Tick()
Rechargeable fans and lamps	
Solar energy	
Generator	
others	

4. If you are using generators, the please answer the questions from "a" to "h".

   a) What type of generator you are using?

Run by Petrol	Run by diesel	Run by gas

   b) What is the maximum power potential of the generator (in terms of KVA)? ……………………………

   c) What was the price of generator?.............…………………………………….

d) When did you buy generator?................…………………………………………………

e) How many hours does your generator run a day? ………………………………….

f) If you are using a petrol generator, how many liters of petrol are consumed in one week? ……………………………………………………………………………….

g) If you are using a diesel generator, how many liters of diesel are consumed in one week?……………………………………………………………………………….

h) What are the environmental threats of generators?

Generate Smoke	Generate noise	Both

5. If you have installed solar energy system, please answer the questions from "i" to "l".

i) What is the power capacity of solar energy system? …………………….

j) What was the installation cost of solar energy panels? „…………………

k) What is the normal life of solar energy system? …………………………

l) What are the environmental benefits of using solar energy?

Does not generate smoke	Does not create noise	Both

Section D

This section of the questionnaire refers information on metering and electricity conservation plans.

1. Meter type: Analogue [   ] Digital [   ] Prepaid [   ]

2. Did you have meter before the introduction of Pre-paid Meters? Yes [   ] No [   ]

3. if yes, what was your range of monthly bill?

Less than N2,000	N2,000 - N5,000	Above N5,000

4. If you now have a prepaid meter, do you spend more on electricity bill?

Yes [   ]   No [   ]

5. If your answer is **yes**, which of the following provide the like explanations?

Please tick the correct response using the response options on the right side of the paper stated as: **Not at all= 0, A little = 1, Quite a bit = 2 and Extremely = 3**.

	0	**1**	**2**	**3**
You are using more electrical appliances than before				
You have less electricity supply now than it used to be				
Your house was not metered, so you pay small amount as monthly 'loss of revenue charges'.				
You used				

6. Do you prefer old metering system to the pre-paid meter? Yes [   ]   No [   ]

Section E

This section of the questionnaire refers information on economic status of household. (Tick where applicable)

1. Estimation of total household monthly income:

Income Group:

a.   10,000 - 20,000   [   ]

b.   21,000 - 30,000   [   ]

c.   31,000 - 40,000   [   ]

d.   41,000 - 50,000   [   ]

e.   51,000 - 70,000   [   ]

f.   71,000 or above   [   ]

2.   Does the household have these items?

Item	Yes	No	If Yes, number of Units
Freezer			
Refrigerator without freezer			
Refrigerator with freezer			
Wash machine			
Dish washer			
Television			
Two or more TV's			
Personal computer			
Video or DVD			
Printer			
Lighting Bulbs			
Number of energy saving bulbs			