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Deleterious Emission Abatement through Structured Energy Use Pattern: A North Central Nigeria Perspective

Ademola AJAYI-BANJI[1]*, Olayinka OMOTOSHO[2], Anthony AMORI[3], Damilola ALAO[4], Imoisime IGBODE[4], Olufemi ABIMBOLA[4]

[1]Agricultural and Biosystems Engineering Department, University of Ilorin, P.M.B 1515, Ilorin, Kwara State, Nigeria,

[2]Agricultural Engineering and Environmental Unit, Institute of Agricultural Research & Training, University of Ibadan, UI Road, Ibadan, OYO, Nigeria

[3]Agricultural & Bioenvironmental Engineering, Federal Polytechnic Ilaro, P.M.B. 50, Ilaro, Ogun State, Nigeria

[4]Agricultural and Environmental Engineering Department, University of Ibadan, UI Road, Ibadan, OYO, Nigeria

Abstract **– Holistic view of household energy consumption based on greenhouse gas emissions in the North Central cities of Nigeria was examined in this study. Scenarios considered were based on income level of energy users (low and high) and energy metering system (i.e. pre-paid and post-paid energy billing systems). Strong direct nexus was observed between energy use and emissions pattern. Energy utilization by post-paid category had higher weekly average value of 35.09 and 41.70 kWh as against 23.18 and 33.38 kWh for low and high income pre-paid consumers respectively. Energy use and greenhouse gas emissions from both classification followed similar trend. Data obtained and analysed in the study show that global warming and acidification potentials could be reduced by 33.94 and 19.95 % for low and high income category consumers when pre-paid meters are in place. Conclusively, energy system users with pre-paid metering system displayed reasonable level of management decisions that reduce energy wastage and consequently environmental negative impacts.**

Keywords **– Greenhouse gases; climate change; emission pattern; energy use; metering system**

1. INTRODUCTION

The core of socio-economic development and sustainability in any nation is energy. Its availability and utilization in developing and underdeveloped countries raise principal concern especially in locality with increased demand resulting from population explosion, innovative technology, populace fiscal buoyancy and urbanization [1], [2]. While reactions by some nations are elastic to this demand growth and have solved the puzzle by increasing energy production, others have complemented its supply with energy use reduction pattern. Most developed nations have not only catered for this demand surge, energy classification with respective energy-related CO2 emissions quantification and mitigation measures and policies have been adopted in these environmentally concerned states [2], [3].

However in Nigeria, the most populous African country, electricity demand far exceeds the epileptic supply capacity. This misnomer can be attributed to increased consumers' demand as a

* Corresponding author.
E-mail address: ajayibanjiademola@gmail.com

result of explosive population growth, rural-urban migration and emergence of mega production industries while supply has been constrained by moribund technology, poor maintenance culture and vandalism. The supply deficits have been managed through deliberate load shedding, intermittent and extensive periods of power outages in some parts of the country. The energy crises have dwindled socio-economic development despite the vast available natural resources [4]. Currently, the nation's total installed capacity is 10,396 MW with an insufficient output production of between 4,000 to 6,056 MW. Regardless of this lingering challenge [5], projected the nation's energy demand would rise from 33 TWh in 2011 to between 56 and 95 terawatt hours by 2020. This will amount to peak load demand increment from 5,000 MW power generated in 2011 to between 80–220 % by 2020. Currently, the principal sources of power generation currently in Nigeria are hydro and thermal energy, though other partly harvested or outrightly unharnessed sources are existing [6]. According to reference [7] potential energy unharnessed in the country is about 56 % of obtainable installed capacity.

Diverse findings revealed energy as deleterious emissions emitter, environmental depletion compositions source and climate change causer. Greenhouse gases (GHG) emissions from this root result in ozone layer depletion, polar ice cap melt and global warming [8] while acid rain formation from the gaseous emissions degenerate metal through corrosion and other notable adverse effects [9]. Recent studies [10], [11] have established connection between energy use pattern, carbon track and householder income level. In view of this, government is obliged to adopting sustainable technologies or practices to curb undue increased GHG emissions generation in a bid to meet the low carbon society standard. Vibrant metering regime for power consumption is key to achieving this. This is because energy use has been strongly linked to emission generation, especially in South-Western Nigeria [1]. In the research, reduction in global warming and acidification potential was ascertained by pre-paid metering platform adoption with respect to householders' different levels of income.

The study examines the bond and influence between the rate of electricity consumption per household in North Central Nigeria using different metering technologies as installed by the Distribution Company and the respective income levels. Possible point-of-generation environmental impact associated in form of greenhouse gas emission coefficient resulting from electricity usage by households in the same zone of the country.

1.1. Study Area

North Central region of Nigeria, one of the six geopolitical zones of the country, was chosen as the investigated locality. Population distribution for this region is 20,369,956, with total household of 3,892,927 and 43.9 % access to electricity [12]. The choice of Ilorin and Abuja was due to the cosmopolitan nature of the two cities. Abuja, the Federal capital of the country, has a mix of high income earners who reside within the city's central region and low income earners who dwell in the fringe zones of the city. Meter reading for Abuja was taken from households in Bwari, Dutse, Wuye and Wuse districts of the city. Ilorin, the capital of Kwara state, has a fairly homogenous mix of both high and low income earners. This contrast Abuja's stratified nature of residency.

1.2. Electricity Administration and Pricing in Nigeria

Energy market attracts global attention and forms the principal agenda in most nations' development plan. Nigeria's perspective fit as case study due to the electricity sector scheme [13]. Although the electricity price forecast and selection system in the country has been ill-defined and unclear since the commencement of the sector [14]. Various strategies employed to address this energy billing systems challenge are the policy formulations and reforms by the National Electricity Power Authority (NEPA) now Power Holding Corporation of Nigeria

(PHCN). Most recently, power reforms in the nation have led to the disintegration of PHCN into Transmission Companies, Generation Companies (GENCOs) and the Distribution Companies (DISCOs) overseen by National Electricity Regulatory Commission (NERC). Nigeria has 82 GENCOs (on-grid, off-grid and embedded generation), 15 DISCOs (major and minor), 1 Transmission company and 1 Bulk Procurement and Resale Company [15].

A scrutiny of the current energy billing system components shows that a typical electricity bill in the country is made up of the Fixed Monthly Charge (FMC) and the Monthly Energy Charge (MEC). The FMC component of the bill caters for installation maintenance while the MEC is associated with consumer energy usage. Consumers' charge categorizations are Industrial (D), Residential (R), Commercial (C), Special (A) and Street Lighting (S). A Multi-Year Tariff Order-2 (MYTO-2) plan for both FMC and MEC was also put in place by NERC and enforced 1st June 2012. This MYTO-2 billing plan underscore that aggregate cost of energy would be on the increase in response to projected inflation and other factors (Table 1).

TABLE 1. MONTHLY MULTI-YEAR TARIFF ORDER-2 FOR THE STUDY AREAS [15]

DISCO	Charge	Residential bill type	2012 (₦)	2013 (₦)	2014 (₦)	2015 (₦)
Abuja	Fixed Charge	R1	--	--	--	--
		R2	500.00	702.00	986.00	1,384.00
		R3	37,527.00	52,696.00	73,997.00	103,908.00
		R4	113,358.00	136,030.00	191,016.00	268,228.00
	Energy Charge	R1	4.00	4.00	4.00	4.00
		R2	11.74	12.62	13.25	13.91
		R3	22.62	22.62	23.75	24.94
		R4	22.62	22.62	23.75	24.94
Ibadan	Fixed Charge	R1	--	--	--	--
		R2	500.00	500.00	625.00	781.00
		R3	18,764.00	18,764.00	23,453.00	29,314.00
		R4	117,267.00	117,267.00	146,573.00	183,202.00
	Energy Charge	R1	4.00	4.00	4.00	4.00
		R2	12.30	12.91	13.56	14.23
		R3	23.40	24.57	25.80	27.09
		R4	23.40	24.57	25.80	27.09

2. CLIMATE CHANGE AND ENERGY USE AUDIT CONCEPT

2.1. Climate Change and Energy Use

According to [16] personal opinion on climate change is key to assessing the willingness to accept the scientific conclusion that humans are global warming causers. Reference [17] shows that much emphasis has been devoted to the science of climate change with deficiencies on the education of the people and how the causes and impacts are perceived. These further strengthen the need for adequate review of the causes of GHG emissions with the view of reducing them to the barest possible minimum through proactive and pragmatic steps.

According to [18] effective reaction to climate change is anchored by mitigation action. Reference [19] further opines that effective mitigation action is achieved by end users precise and time bound instructions on emissions reduction achievement by interventions in the energy system over some timeframes. Still in support of the need to reduce the effect of climate change, [20] observes that focused and effective interventions, including jettisoning technologies and infrastructures fostering greenhouse gas emission could drastically mitigate future climatic changes.

The buttressed points support Intergovernmental Panel on Climate Change view, that energy is the most sensitive contributor to climate change. This is linked to the alarming quantity of unwholesome gases released to the environment either in pure or combined state with atmospheric elements. Emission discharge rate was directly linked to the grandiose energy demand as a result of increasing expenditure per capita, population, spending habit, income and urbanization [2], [21]. While the resultant environmental degradation from the discharged greenhouse gases has prompted environmental concerns and emission checks in some nations. Hence, some developed nations have produced strategies and policies aimed at checkmating the menace. Some of the measures adopted by most developed countries include energy use minimization and optimization. Another explored option is renewable energy usage [22], [23]. Regardless of the global threat posed by this phenomenon, Nigerians and the Nigerian government is focused mainly on energy generation, neglecting the aspect of efficient energy utilization by the end users even with the glaring environmental consequences. Most energy studies in the nation expressed general emission abatement measures [24], [25].

2.2. Energy Audit

A simple gate- to- gate life cycle assessment for domestic energy consumption in Nigeria is presented in Figure 1. Emissions, heat and sound are some of the energy supplied offshoots from the National grid.

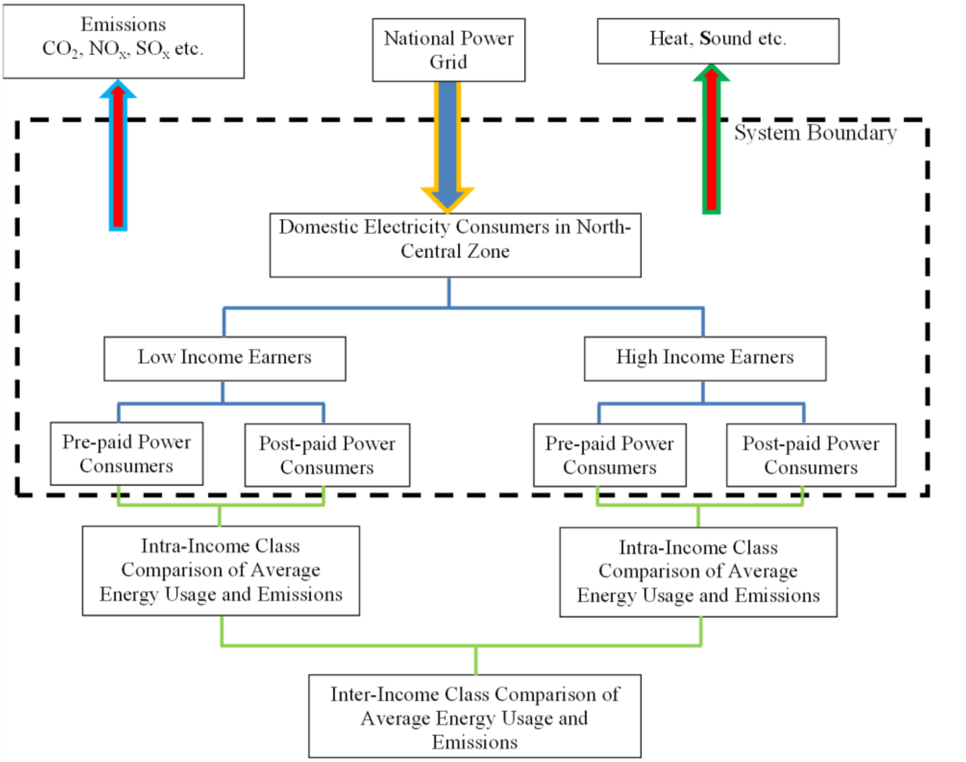

Fig. 1. Gate-to-Gate LCA of domestic energy consumption in North-central Nigeria.

3. METHODOLOGY

3.1. Income Level Classification of Energy Consumers

World Bank presently classifies Nigeria as a low medium income earning one and developing country according to International Monetary Fund classification based on the developmental level of the nation [26]. For the purpose of this research end users were classified in relation to earned income as low (below ₦ 48,000.00 per month or $290 per month) and high income earners (above ₦ 48,000.00 per month). Although this yardstick is lower than United Nations and MDGs categorization it was necessary to create the pseudo-class in order to facilitate comparison of energy usage and attending effects within the country. This classification represents the generally accepted view of living standards in the North Central region of Nigeria (Authors' Personal Interview). Randomized selections of houses were carried out for the four classifications without bias. The groupings were pre-paid low income earners (PLIE), post-paid low income earners (POLIE), post-paid high income earners (POHIE) and pre-paid high income earners (PHIE).

The functional unit of the gate-to-gate LCA study is the domestic household energy users which are classified into the four household groups with the energy consumption units measured in KWh. In this 'gate-to-gate' approach only inputs from power generating plants (i.e. hydro and thermal) supplied through the national grid and outputs (i.e. emissions, heat, sound) associated with the processes within the boundary are included.

Inventory was taken from analogue post-paid and digital pre-paid meters installed in high and low income households. Readings were taken at an average weekly power supply rate of 77 hours per week for the four functional units. A sample size of 161 households consisting of functional units of 17 PLIE, 51 POLIE, 58 POHIE and 36 PHIE were randomly selected and energy consumption was measured using the above mentioned criteria. The choice of functional unit distribution in the sample space was made based on the approximate consumer class distribution in the population.

Respective meters readings were obtained at specific intervals over a period of eight weeks and the average power consumption (P_{avg}) per household calculated using equation (1).

$$P_{avg} = \frac{(R_8-R_7)+\cdots(R_2-R_1)+(R_1-R_0)}{8} \quad (1)$$

where

R_0 meter reading at the beginning of the study;

$R_1, R_2 \dots R_8$ meter readings from week 1 to week 8.

Power consumption per functional unit (PCFU) was computed by the mean value estimate of the P_{avg} for each of the functional unit as given in equation (2).

$$P_{CFU} = \frac{\sum P_{avg}}{n} \quad (2)$$

where

n number of households considered for each functional unit.

3.2. Emission Loads Computation

LCA results were calculated in terms of the various environmental impact categories. The impact categories selected for this study were global warming potential (GWP) based on a time horizon of 100 years and acidification potential (AP). These two impact categories were selected based on the goals and intended use of the results and were in accordance with the LCA methodology as stated by [27], [28], [29], [30].

Between year 2012 and 2015 the nation's total electricity production output has consistently hovered around 3200 and 4000 MW. This output is made up of a combination of hydroelectric and thermal stations. With hydroelectric stations having a total installed capacity of 1900 MW, however the available capacity may drop to as low as 40 %, thus the remainder of available power is made up by thermal stations.

$$Total\ GHG\ Emission = GHG_{plant} + GHG_{grid} \quad (3)$$

$$GHG_{plant} = \psi Q \quad (4)$$

where

ψ Power generation (MWh);

Q Emission factor;

but

$$\psi = \alpha\mu\phi \quad (5)$$

where

α	Installed capacity (MW);
μ	Output capacity (%);
ϕ	Total annual hours of production (hrs).

$$GHG_{grid} = \Omega\Delta\lambda \tag{6}$$

where

Ω	total electricity output of grid (MWh);
Δ	percentage contribution to grid (%);
λ	emission factor for specific technology and or fuel type (tons of factor/Mwh).

$$Total\ Emission = \psi Q + \Omega\Delta\lambda \tag{7}$$

$$Emission\ factor\ (\text{Ɏ}) = \frac{Total\ Emission(Kg)}{Power\ Generation(kWh)} \tag{8}$$

$$\text{Ɏ} = \frac{\psi Q + \Omega\Delta\lambda}{\psi} \tag{9}$$

Emission factors for direct energy usage (electricity usage) as listed in Table 2 were based on the power mix in the national grid which comprises 22.4 % hydropower and 77.6 % thermal power (using natural gas as fuel) as previously reported by [31], [32].

Emission factors were multiplied by the average power used by each household class in order to estimate pollutant emissions in kilograms GWP, an estimation index for global warming contribution due to atmospheric emission of GHGs, was calculated using the CO2–equivalent factors as supplied by Intergovernmental Panel on Climate Change [33] as CO2 = 1, CH4 = 25 and N2O = 298, while the SO2–equivalent factors (SO2 = 1 and NOX = 0.7) were derived from [34], [35] and used in calculating GWP and AP (Equations 10 and 11).

$$GWP = \sum_{j=1}^{n} ef_{GWP,j} M_j \tag{10}$$

where

$ef_{GWP,j}$	GWP factor of gas j expressed relative to the value for CO_2;
M_j	$ef_{GWP,j}$ emission in kg per functional unit.

Table 2. Electricity Emission Factors Based on the Power Mix in the National Grid [31]

Emissions	Emission factors Ɏ (kg/kWh)
CO_2	1.42E-01
CH_4	2.71E-05
N_2O	2.65E-06
SO_2	7.21E-07
NO_x	1.18E-04

$$AP = \sum_{j=1}^{n} ef_{AP,j} M_j \tag{11}$$

where

$ef_{AP,j}$	AP factor of gas j expressed relative to the value for SO_2;
M_j	$ef_{AP,j}$ emission in kg per functional unit.

4. Results and Discussion

4.1. Energy Use Audit

Energy use audit result for investigated household shows that the nature, quantity and energy efficiency level inclusive for home appliances plays major role in energy use characteristics determination. Table 3 shows an inventory of the representative appliances obtainable in residences with regards to the income classes as defined by the study (Personal Interview). Aside the basic requirements as obtainable in low income earning households, high income consumers have status defining appliances which also add to the power load in such homes.

TABLE 3. INVENTORY OF APPLIANCE POWER RATING IN DOMESTIC CLASSIFICATIONS OF POWER CONSUMERS

Low Income Earning Residences		High Income Earning Residences	
Equipment	Power Rating (Watts)	Equipment	Power Rating (Watts)
Refrigerators	100–120	Refrigerators	100–120
Cathode tube TV sets	65–120	Deep Freezers	110–155
Lighting	40–100	Cold Water dispensers	100–120
Water heaters	1000–1200	Lighting	40–200
Fans	70	Water heaters	1000–1100
Stereo sound systems, DVD players	150	Fans	70
		Air conditioners	1000–2200
Digital TV Decoders	10	Electric ovens	1200
Pressing iron	1000–1200	Microwave ovens	1200
Blenders	75–100	Hi fi Sound systems, DVD players	150
Water pumps*	750–1500		
		Digital TV Decoders	10
		Plasma/LCD/LED TV sets	15–300
		Washing Machines	240
		Utility Equipment	
		Bathroom water heaters	1100
		Pressing irons	1100
		Vacuum cleaners	1000
		Water pumps*	750–1500
		Blenders	75–100
		Deep fryers	1000–1100

4.2. Average Energy Consumption

Result analysis shows that 22 % of the randomly selected residences were in the post-paid high income class, 36 % were pre-paid high income category, 11 % were low income pre-paid consumers while 31 % were low income post-paid consumers (Figure 2). Variation in household number was catered for by the computation of the respective mean values of the energy usage for each income earners class (Tables 4 & 5).

TABLE 4. INCOME-METERING CORRELATIONS FOR GWP

	Mean	SD
POHIE	6.03	1.79
PHIE	4.47	1.92
PLIE	3.11	2.31
POLIE	5.25	0.986

TABLE 5. INCOME-METERING CORRELATIONS FOR AP

	Mean	SD
POHIE	0.0051	0.0015
PHIE	0.0038	0.0016
PLIE	0.0026	0.0019
POLIE	0.0044	0.0008

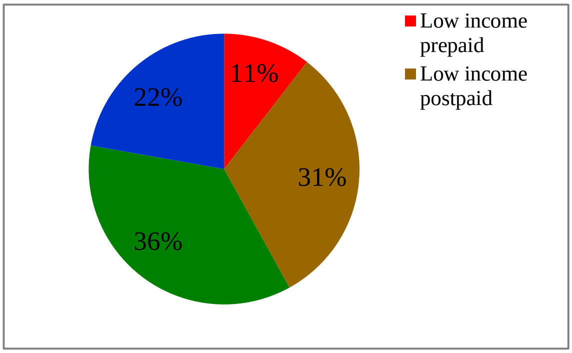

Fig. 2. Income-Metering Class Composition.

Average weekly energy supply computation for 77 hours illustrates highest average energy consumption pattern with post-paid high income earners while low income earners had the lowest of the classes. A comparison of the metering classes however shows that the pre-paid consumers (high and low income earners) had lower average direct energy usage values. Specifically the average weekly power usage was 23.18, 35.09, 33.38 and 41.70 kWh for PLIE, POLIE, PHIE and POHIE respectively (Table 6). POHIE recorded the highest consumption average and this might be attributed to the luxuriant living standard of these earners class coupled with the weather condition in this region of the country. The latter necessitates high demand for air conditioning as well as other conveniences. This contradicts findings from a similar study on south western part of the country as conducted by [1]. Findings from the study reveal that POLIE class had the highest average energy consumption value. The authors attributed the south-western Nigeria results to other factors aside the ones stated in this study. High population density and high rate of wastage due to erroneous billing system by the power supply companies amongst others were the factors linked with the result.

TABLE 6. INVENTORY OF EMISSION COEFFICIENTS AND ENERGY USE

	Average Energy Consumption (kWh/FU)	Reduction in Energy Consumption (%)	Emission Equivalents				
			CO_2	SO_2	CH_4	N_2O	NO_x
PLIE	23.18	33.94	3.29	1.67E-05	6.28E-04	6.14E-05	2.74E-03
POLIE	35.09		4.98	2.53E-05	9.51E-04	9.30E-05	4.14E-03
PHIE	33.38	19.95	4.74	2.41E-05	9.05E-04	8.85E-05	3.94E-03
POHIE	41.70		5.92	3.01E-05	1.13E-03	1.11E-04	4.92E-03

CO_2 = 1, CH_4 = 23, N_2O = 298 were the global warming potentials used [33]

Average direct energy consumption per functional unit comparative test in this study depicts that both classes of consumers (low and high income earners) exhibited significant reduction in energy wastage tendencies. However, the low income earners demonstrated much greater reduction in average energy consumption of 33.94 % when metering system was changed from post-paid to pre-paid. While the high income earners displayed 19.95 % reduction in average energy consumption due to change in metering system (Table 6). It can be inferred that low income earners exhibited lifestyle switch thereby cutting down on power wastage as more consciousness for energy usage with use of pre-paid metering systems were observed. In contrast, the high income earning categories are indifferent about reducing their energy consumption as is the case of their low income counterparts. This response may be attributable to their ostentatious lifestyle which requires additional energy utilization. These categories of consumers have well equipped household composition or utility gadgets such as air conditioners, freezers, washing machines, microwaves, entertainment gadgets etc. This depicts that high standard of living and material affluence significantly contributes to energy consumption. This is in consonance with findings from a study on energy consumption trend as reported by [36]. In general, energy management lifestyle for householder categorization in developing nations could be ostentatious (above level N), modest (below level N) and indifferent (level N) depending on income level, metering system, end user altitude and societal influence as shown in Figure 3.

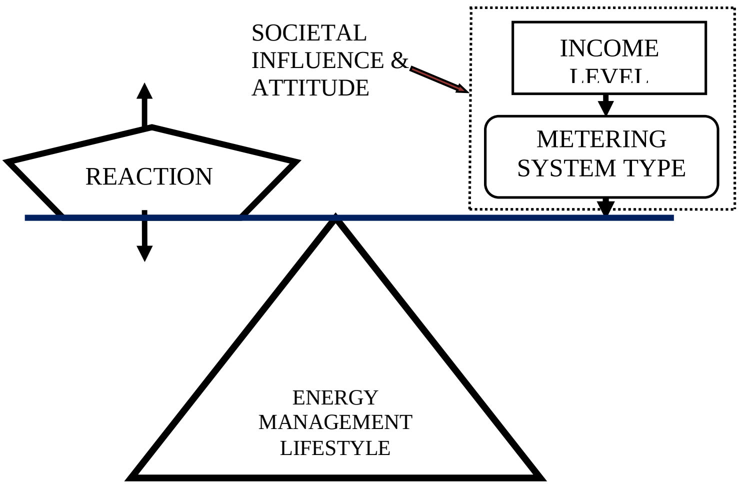

Fig. 3. Anthropogenic energy management scale.

4.3. Consumption Load Emission

Reference [37] in a study on energy cost with respect to emissions observed that low energy prices were directly linked with effort to mitigate greenhouse gases. The former threatens effort to mitigate GHG emissions. However, householder lifestyle choice and orientation also influences the success rate of conservation efforts. In general, pre-paid meters users showed greater level of responsibility in energy waste conservation when compared to their post-paid counterparts on both income levels (Table 6). The lower weekly data for pre-paid users show good attitudinal and behavioural change towards energy usage as opposed to their post-paid counterparts. This agrees with [38] findings in a study on energy consumption and demand in Nigeria. Hence the displacement of post-paid meter and introduction of pre-paid meter facilities to the Nigerian power market is expected to bring about more value for money paid by end users and also cut down wastages at consumers end.

4.4. Global Warming Coefficients

Environmental gases considered for global warming in this study were CO_2, CH_4 and N_2O with the respective emission coefficients based on energy use. According to [39] affluence primarily contributes to emissions generation rate resulting in high carbon society. This can also be observed to be true in the case of domestic households in north central Nigeria although the categorization adopted in this study is based on householder income level and metering system type. Consumption from households with high income using post-paid meters (POHIE) had the highest value of 6.03 $kgCO_2$ equivalent/functional unit. However, households with low income using pre-paid meters (PLIE) recorded the lowest value of 3.11 $kgCO_2$ equivalent/functional unit of global warming potential (Table 6). In summary, both income classes of consumers in the post-paid category contributed. In summary, both income classes of consumers in the post-paid category contributed more to global warming when compared to the pre-paid counterparts (Table 4). Similar trend was observed by [38] in a study conducted on energy consumption and demand in tertiary institution. It is observed that pre-paid users obviously have attitudinal and behavioural change as opposed to post-paid users. This further implies that pre-paid metering system contributes to the enhancement of environmental integrity and economical management as observed by Abimbola *et al.,* (2014).

4.5. Acidification Potential Coefficient

The acidification potential of emission result determined from NO_x and SO_x group of gases shows that consumption from low income households using post-paid meters (POHIE) had the highest value of 5.1 x 10^{-3} $kgSO_2$ equivalent/functional unit. On the other hand, the high income households using pre-paid meters (PLIE) recorded the lowest value of 2.6 x 10^{-3} $kgSO_2$ equivalent/functional unit of acidification potential as shown in Table 6. The acidification potential pattern shows that the same trend was exhibited for global warming potential. This proves that the post-paid meter users contribute more in terms of acidification potential when compared with the pre-paid consumers. Energy consumption trend for both the pre-paid and post-paid consumers indicates that energy wastage was minimized with the introduction of pre-paid metering system. This suggests that there is direct nexus between the consumer's perception of the metering system and their energy use pattern. Most consumers exhibit a high level of responsibility, attitudinal change and lifestyle modification in terms of energy consumption when availability is based on their economic capability as opposed to the credit form of tariff system used under post-paid system of power usage. The pre-paid system is a better alternative to the credit form of billing system which is fast becoming ineffective and leading to energy wastage on the part of consumers. Also, the system compensates for the seemingly unjust bills distributed at the end of each credit period and keeps both the GENCOs and DISCOs on their toes as the income generation will only be based on service delivery. It is believed that drastic reduction in energy wastage could make energy supply and provision more effective thereby leading to a better overall efficiency of the system. Emissions from the combustion of fuel will attain an alarming level in no distant future if appropriate measures such as reduction in use of fossil fuel and employment of environmentally friendly options of power generation are not implemented by the government. To this end the use of renewable sources of energy is much desired especially in a country adjudged to be rich in natural resources.

5. CONCLUSION

Findings from this study have shown that most consumers are more responsible and accountable in terms of energy utilization with the introduction of pre-paid metering system. It was also observed that high income earners demonstrated a lower propensity to reduce energy wastage due to the high energy demand associated with their ostentatious lifestyle in contrast to what is obtainable with low income earning consumers. Although the recent increase in electricity tariff due to privatisation of the power sector by the government in the country has been viewed as having an inimical effect on the economy since it may lead to increased cost of production, it may be viewed as not totally on the negative side. This is because it will aid the reduction of energy wastage especially with the use of pre-paid meters. Results from this research also shows that the high income post-paid energy consumers in the North Central zone of Nigeria have the highest global warming and acidification potential indices while the pre-paid low income consumers exhibited the lowest emission rates. However, a holistic view of the scenarios shows that the post-paid consumers, high and low income, have higher values of emission rates as compared to pre-paid consumers. This is also in consonance with results of similar studies conducted for the South Western zone of the country. The country should endeavour to join the league of environmentally conscious and friendly nations through environmental inclined policies formulation and especially the full implementation of the usage of the pre-paid metering nationally.

6. RECOMMENDATIONS

DISCOs are advised to expedite action on prompt issuance and monitoring of pre-paid meters to their customers as this has proved to be more efficient both in curbing energy wastages and undue emission generation. The government is also advised to accelerate action on policy formulation and implementation in order to enforce sole pre-paid metering system usage in Nigeria. To lower the emissions from power generation, government should find the optimal mix of fuels for the diversification of electricity supply in Nigeria. There should also be increased awareness on the use of energy efficient appliances to aid the reduction in energy consumption. The use of high quality low energy bulbs should be encouraged to replace the currently popular incandescent bulbs. Continuous orientation of electricity consumers is a necessity in order to reduce wastages and lower off-gases generation.

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Ademola A. Ajayi-Banji has a Bachelor of Science in Agricultural Engineering (2008), Master of Science in Agricultural & Environmental Engineering, environmental engineering option, (2012). LECTURER at the Department of Agricultural & Biosystems Engineering, University of Ilorin, Nigeria. Research Interest – Waste management, biomaterial utilization, biofuel and emission abatement. MNSE, ASABE, NIAE, COREN (R. Eng). Presently he has seven international publications and a conference proceeding to his credit.
Agricultural & Biosystems Engineering Department, Faculty of Engineering & Technology, University of Ilorin, P.M.B. 1515, Ilorin, Kwara State, Nigeria.
Phone: +234 703 656 8275; E-mail: ajayibanjiademola@gmail.com

Olayinka A. Omotosho has a Bachelor's Degree in Agricultural Engineering as well as a Master's in Agricultural and Environmental Engineering with an area of specialization in Environmental Engineering. He is currently pursuing his PhD. in Agricultural and Environmental Engineering with bias to Structures and Environmental Engineering.
The author is a RESEARCH FELLOW at the Institute of Agricultural Research and Training, Obafemi Awolowo University, Moor Plantation, Ibadan, Nigeria.
He has published six international journals, two local journals and has four conference proceedings to his credit. He has research interest in wastewater treatment and reuse as well as renewable energy technology. The Author is a Corporate Member of the Nigerian Society of Engineers, a member Nigerian institution of Agricultural Engineers.
E-mail: akintoshforever@gmail.com

Anthony A. Amori obtained his Bachelor's degree in Agricultural and Environmental Engineering at the University of Ibadan and Master's degree in Environmental Engineering specialization in the year 2008 and 2012 respectively. He is currently a LECTURER in the Department of Agricultural and Bio-Environmental Engineering, at Federal Polytechnic Ilaro, Nigeria. He formerly lectured in the Mechanical Engineering Department of the same institution before his current assignment.
The author has consistently developed his expertise in research in Environmental Engineering over his post-graduation leading to publication five (5) international peer-reviewed journal publications, and 4 conference proceedings.
He is a graduate member Nigeria Society of Engineers and currently processing registration as a corporate member of Nigerian Institute of Agricultural Engineering.
Department of Agricultural and Bio-environmental Engineering, Federal Polytechnic, Ilaro, Ogun State, Nigeria. Phone: +234 803 415 1316
E-mail: amori_anthony@yahoo.com, amorianthony@federalpolyilaro.edu.ng

Damilola A. Alao, M.Sc. in Environmental Engineering, University of Ibadan, Nigeria (2012) and B.Sc.in Agricultural Engineering, University of Ilorin, Nigeria (2007). Major field of study is environmental engineering.
Presently an INTRUCTOR in the Engineering Department of Nigerian Army School of Signals, 2A Marine Road, Liverpool Apapa-Lagos, Nigeria. Worked previously in Gifted Hands Stitches as a CLOTHIER. She is one of the authors of Abimbola, O., Amori, A., Omotosho, O., Omoyeni, D. and Ajayi-Banji A., Investigation of Energy Use Pattern and Emission Discharge in Nigeria: A Case Study of South West Zone in International Journal of Engineering and Technology Innovation, vol. 5, no. 1, 2015, pp. 56–65.
Her areas of research interest include waste management, pollution control, renewable energy and wastewater engineering. She is a member of Nigerian Institute of Agricultural Engineers.

Imoisime E. Igbode has a Bachelor's degree in Agricultural and Environmental Engineering from Rivers State University of Science and Technology and a Master's degree in Agricultural and Environmental Engineering from University of Ibadan, Ibadan, Oyo State, Nigeria. He has research interest in bioremediation and environmental protection strategies. The author currently has 2 international journals to his credit.
E-mail: ehiransome@yahoo.com

Olufemi Abimbola is currently a PhD candidate at University of Ibadan, Nigeria. He graduated with two master degrees in Water Science and Engineering (UNESCO-IHE, Netherlands) in 2014 and Environmental Engineering (University of Ibadan, Nigeria) in 2012. He studied Agricultural and Environmental Engineering at University of Ibadan and graduated in 2008.
He is a research officer (water resources and environment) at EDEN Nigeria. He currently coordinates and contributes to research associated with surface and groundwater hydrological modelling, irrigation, drainage, soil and water conservation techniques, and Life Cycle Assessments (LCA) of products and processes. He is interested in simulation, analysis and design of water resources and environmental engineering systems as well as LCA studies. He has developed efficient and parsimonious tools for solving problems and applied them to a range of water resources and environmental engineering problems including the hydrological modelling of flow quantiles of Rwanda. He has co-authored five international peer-reviewed papers and one international book chapter. He is an Associate Member, American Society of Agricultural and Biological Engineers; Associate Member, American Society of Civil Engineers; Member, International Association of Hydrogeologists; Graduate Member, Nigerian Society of Engineers. He received a scholarship from Netherlands Fellowship Programme for postgraduate study at UNESCO-IHE Institute for Water Education, The Netherlands in 2012.
Address: 11, Bode Kumapayi Street, Iwo Road, Ibadan, Oyo State, Nigeria. Phone: +234 802 078 5267
E-mail: femi_abim@yahoo.com