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A SURVEY Of ENERGY-EFFICIENCY PRACTICES IN NIGERIAN HOUSEHOLDS

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Introduction

The global economies of the developed and developing worlds have acknowledged the need for energy conservation and are beginning to put in place strategies for its realization because of circumstances surrounding energy sustainability in the built environment. Many researchers, including M. Hegger et al. and D. Wulfinghoff, have noted that "no other sector of the economy uses more materials and energy, produces more waste and contributes less to material recycling than the building industry" with almost "50% of the total invested capital in developed nations tied up in the housing sector; and approximately 70% in existing buildings."[1] However, the energy demand in Nigeria—as in most of the developing world—is on the rise as households increase their appliances and equipment use with improvements in their economic and social status. At the same time, many of these countries have constrained national power supplies that

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cannot meet demand and suffer from frequent outages. This phenomenon, in addition to the global "energy scarcity," has led to a greater awareness of the need to make fundamental changes in the patterns of consumption.[2] Furthermore, the question of inefficient housing and the associated human problems that are likely to be responsible for this inefficiency has given rise to the push to study individual houses and the disposition of their occupants.[3] This study therefore focuses on the human dimension of energy use, which can provide a significant boost in the more efficient use of all energy resources if well understood and if behavior patterns can be shaped accordingly, as noted by K. Ehrhardt-Martinez.[4] The role of human social behavior and its potential impact on energy conservation often has been overlooked in energy analysis in spite of the fact that it can significantly amplify or reduce the effects of technology-based efficiency improvements.[5] This viewpoint is buttressed by the statement of L. Schipper, as cited in L. Lutzenhiser, that "those of us who call ourselves energy analysts have made a mistake. . . we have analyzed energy. We should have analyzed human behavior."[6] This underpins the adoption of the behavioral approach as the economy or technology-based models have offered limited contributions to policy makers and politicians on how to initiate enduring developments toward energy conservation.[7]

Based on this premise and the growing need for Nigerian society to embrace the culture of energy-efficiency practices to counter the prevailing energy scarcity, this study was undertaken. Moreover, as Nigeria is the most populous state in Africa, the findings from this study not only have ramifications at a nationwide level but also could be utilized by other countries on the continent and emerging economies that face similar energy issues. This paper presents the results of a small-scale (pilot) study and offers a framework for an expanded research study that would outline energy-efficiency practices for Nigerian households. The intended goal is to improve our understanding of energy consumption at the household level and, subsequently, enhance efficiency practices. The objective of this particular research, therefore, is to determine the level of people's perception and pattern of energy-efficiency practices at the household level in Nigeria. Yet, as A. Hedges has suggested, people are generally in favor of energy efficiency but do not know how to achieve it and are concerned that their comfort level might be compromised in the process.[8]

The Theoretical Framework

G. Gardner and P. Stern have indicated in their analysis of U.S. households that energy consumption can be reduced by up to 30 percent, which translates into 11 percent of total U.S. consumption, simply by changing the selection and use of various household and vehicle technologies.[9] However, the study highlights a fundamental problem that, due to the absence of organization and appropriate

and adequate information, households lack accurate and actionable information on how best they can achieve potential energy savings. The study went further to suggest that the action for reducing consumption

> falls into the classes of curtailment and efficiency. The former involving actual reduction in the frequency or duration of specific activities, such as single-car commuting etc.; while the latter involves one-time actions, such as installing improved home insulation or purchasing new-model, energy-efficient appliances that ensure less power.[10]

The principal contention here, according to D. Williams et al., is that efforts to conserve energy or use it more efficiently would need to concentrate much more on the behavior of the consumer, how he uses his environment, and how he changes his strategy in response to economic forces.[11] Thus, the knowledge of human behavior with respect to energy use is paramount for a successful energy savings and conservation policy.[12]

J. Diez-Nicholas' research shows a correlation between attitude and behavior, and that attitude precedes behavior but does not necessarily determine it.[13] In line with this "social ecosystem" theory, author Diez-Nicholas defines attitude as instrumental collective responses that a population develops in order to achieve the best adaptation possible to their environment, under a given state of the arts (technology).[14] In fact, human population interacts with the environment through culture: a material culture (broadly defined as technology) and a non-material culture (broadly defined as social institutions, beliefs, and value systems). Both of these form collective responses that, once established, may facilitate or prevent further development, including technological development. In addition, the "center-periphery" theory proposes that new attitudes and values are first developed at the center of the society and then spread toward the social periphery. That is, the concern for the built environment is more in developed societies and, within them, among those individuals in higher social positions who are better informed. Thus the hypothesis: "energy efficiency practice (behavior) in the household is influenced by the independent variables of awareness, social status and education."[15]

However, M. Hegger et al. remark, "How our future looks, and in whichever built environment we and future generations experience it, depends on our decisions. Ultimately, it will not depend on technology and economics but on what we—people—decide."[16]

Approaches and Methods

For our study, the method of research was basically quantitative with the use of a structured questionnaire administered on household respondents of Bauchi, Nigeria. The questionnaire was self-administered and of cross-sectional design.

The target population was defined as "all heads/representatives of household units (male or female) resident in Bauchi, but living in formal housing typology of flats/apartments; and not in traditional settings as at the period of this study." This setting does not make it possible for one to establish a sampling frame; thus, the adoption of "cluster sampling," which granted us the opportunity of a probability sampling. As a result, clusters of housing units were established in three distinct locations of Bauchi town in order to generalize the outcome of our results on the entire target population of Bauchi. Bearing in mind that this is a pilot study and also considering the large size of clusters, one had to adopt a two-stage sampling within the housing units to obtain the required sampling size based on the proportion as presented in table 1.[17] In a multi-stage approach (i.e., two-stage), according to J. W. Creswell, you identify clusters and obtain the subjects within the clusters, then sample within them.[18]

The researcher had trained two enumerators, in addition to himself, to assist in administering the questionnaires. A formal session always was held with the respondents to brief and introduce them to the study, clarifying what was expected of them. They were instructed to read properly and answer adequately and independently. Adequate time was given and, in some cases, two days to one week was allowed before retrieving the surveys. This was based upon some respondents' requests due to time constraints on their part.

A total of 80 questionnaires were circulated to the household respondents in the three distinct clusters, but only 56 were retrieved, with some missing values, and six clearly invalid.

As background on the survey location, Bauchi is the capital of Bauchi State, located in the northeastern region of the country. It is located in the savannah belt with sparse vegetation. It experiences both wet and dry seasons with annual rainfall between May and September. The temperatures of Bauchi town are generally high, with mean maximum range of about 29.2°C in July/August to 37.6°C in March/April. The mean minimum range is about 11.7°C in December/January to 24.7°C in April/May. The humidity ranges from about 12 percent in February to about 68 percent in August.

Table 1
POPULATION/SAMPLE SIZE

Target Group (in clusters)	Population	Cluster SampleSize	Cluster Sample (in percent)
Abubakar Tafawa Balewa University Staff Quarters	106	16	15
Federal Polytechnic Bauchi Staff Quarters	77	12	15
Bauchi State Low-Cost Housing Estate	144	22	15
Total	327	50	15

Table 2
PROFILE OF HOUSEHOLD RESPONDENTS

Demographic Variables	Description	Frequency	Percentage
Age	18-27 years	2	4.3
	28-37 years	8	17.4
	38-47 years	21	45.7
	48 and above	15	32.6
Sex	Male	44	88
	Female	6	12
Marital status	Single	6	12
	Married	44	88
Number of household members	1-5	12	25
	6-10	20	41.7
	11 and above	16	33.3
Level of education	Lower	-	-
	Intermediate	9	18
	Higher	41	82
Office position	Junior	2	4
	Intermediate	7	14
	Senior	30	60
	Executive	11	22
House type	Bungalow	32	64
	Semi-detached	4	8
	Row houses	9	18
	Duplex	3	6
	Others	2	4
House ownership	Personal	17	34
	Private	5	10
	Public	28	56
House location	Abubakar Tafawa Balewa Univ. Staff Quarters	16	32
	Federal Polytechnic Bauchi Staff Quarters	12	24
	Bauchi State Low-Cost Housing Estate	22	44
Level of awareness	I don't know/Don't care	5	10
	Very little	6	12
	Little	6	12
	Good	24	48
	Very good	9	18
Household practice rating on a of scale 1-7	1	1	2
	2	6	12
	3	17	34
	4	4	8
	5	14	28

(continued)

Table 2 (continued)
PROFILE OF HOUSEHOLD RESPONDENTS

Demographic Variables	Description	Frequency	Percentage
	6	5	10
	7	3	6
Traditional ways of conserving energy	None	8	16
	Opening/ closing windows	12	24
	Plant landscaping	3	6
	Water-works	1	2
	Selected surface colors	3	6
	Others ("switching off appliance" written in)	15	30
	More than one selection	8	16

Results and Discussions

Earlier research works have prescribed that analysis of any type of pilot study should be mainly descriptive or should focus on confidence interval estimation, as discussed in G. Lancaster et al., depending on the objectives and dimensions of study.[19] Where an inferential statistics is to be employed due to hypothesis testing, the results from the hypothesis testing therefore should be treated as preliminary and interpreted with caution when writing a manuscript.[20] Thus, data obtained from the questionnaire administration were collated, input, and analyzed using descriptive and partly inferential statistics. Bearing in mind the objective of assessing the level of respondents' perception and pattern of energy-efficiency practice, the questionnaire was partitioned into four data levels to address the questions of respondents' perception and the efficiency of appliances in use as follows.

Personal Information Data: It is obvious from the data that the majority of the respondents are male (88 percent), married (88 percent), and in the age range of 38-47 years old (45.7 percent). Some 41.7 percent of the respondents have six to 10 household members in their domicile (see the profile of respondents in table 2).

Most of them have university education (82 percent) while the lower education (No school & Primary education) were non-existent in these environments. The intermediate level (Secondary education) constituted only 18 percent. The fact that the lower education level scores 0 percent is presumably an indication that a majority of this group simply do not have the means to live in housing areas of flats/apartments typology in Bauchi, which reflects the case in most parts of Nigeria. The link between higher education levels and living in this type of housing is essential to keep in mind.

Table 3
CORRELATION RESULTS (PRACTICAL BEHAVIOR RATING/LEVEL OF EDUCATION)[a]

Spearman's rho	Practical Behavior Rating	Level of Education
Practical behavior rating		
Correlation coefficient	1.000	.546[b]
Sig. (1-tailed)	-	.000
N	50	50
Level of education		
Correlation coefficient	.546 [b]	1.000
Sig. (1-tailed)	.000	-
N	50	50

[a]Spearman's rho correlation test statistics = 0.546, significant at the 0.001-level for 1-tailed prediction; the p-value is 0.000 = 0.01 (is therefore significant); $r_s = 0.546$; N = 50; and $p < 0.01$.
[b]Correlation is significant at the 0.01 level (1-tailed).

Housing Information Data: Most of the houses involved were of the bungalow type (64 percent), and a slight majority of public house ownership (56 percent).[21] Only 34 percent of houses were of personal ownership, while the remaining 10 percent were private (i.e., two of the cluster units are public owned while the third was given out on owner-occupier based on ability to pay). The location of the three cluster units are in the urban and suburban periphery.

Energy Use Information Data: This is the critical stage where the perception of respondents and the manner of their efficiency practices are to be assessed. Some 66 percent of respondents have indicated the level of their awareness on a "good" and "very good" scale. This is impressive, but we should bear in mind that 82 percent of respondents have university education, which is likely the responsible factor for their awareness levels (table 2).

Surprisingly, only 44 percent have indicated a rating of 5 to 7 on the given "energy efficiency practice scale (Thurstone) of 1-7." The remaining 56 percent fell within the scale range of 1 to 4 (i.e., "little" to "I don't know/not at all") category. Meaning awareness and practice are two separate entities due to attitude and cultural influences, but the former may lead to the latter (table 2).

The majority of respondents have indicated that they stay more in their houses in the evening period (92 percent) than at any other time. Moreover, the majority of those surveyed contended that "most" energy consumption takes place in the night period (48 percent). This makes sense since the respondents are working class and usually at their places of employment during the daytime, except on weekends when most would be in their homes.

When asked in which aspect is energy consumed most in the house, those surveyed had mixed responses. Though the majority indicated "lighting," it was

Table 4
CORRELATION RESULTS (PRACTICAL BEHAVIOR RATING/LEVEL OF AWARENESS)[a]

Spearman's rho	Practical Behavior Rating	Level of Awareness
Practical behavior rating		
Correlation coefficient	1.000	.644[b]
Sig. (1-tailed)	-	.000
N	50	50
Level of awareness		
Correlation coefficient	.644[b]	1.000
Sig. (1-tailed)	.000	-
N	50	50

[a]Spearman's rho correlation test statistics = 0.644, significant at 0.001 level for 1-tailed prediction; the p-value is 0.000 = 0.01 (is therefore significant); $r_s = 0.644$; N = 50; and $p < 0.01$.
[b]Correlation is significant at the 0.01 level (1-tailed).

clear that there was a lack of understanding on the quantum of energy consumption by appliances. The second problem is the state of the energy supply, which makes it impossible to use certain appliances because of the low rate and inadequacy of power and the erratic nature of its supply.

On the aspect of the traditional practices of conserving energy by individuals, the majority (30 percent) of respondents indicated the "others" category and wrote on their forms that they practiced "switching off appliances when not in use." This was followed by "opening and closing of windows" (24 percent) depending on the climatic condition (ambient temperature).

The inferential statistics (i.e., correlation results) have shown significance at different levels in the relationship of the independent variables of education, awareness, and social status with the dependent variable of environmental behavior; thus, the rejection of the null hypothesis (tables 3, 4, and 5).

Appliances Information Data: This section is the most problematic of all as not all participants responded with complete information. This was probably due to lack of understanding of energy-efficient products and their rating and labeling modes. Many of those surveyed do not have appliances other than the basic ones like lighting, fans, water boilers, electric stoves, electronics, and computer hardware. This is partly because the power level of the electricity supply in most places is too low and cannot carry high-powered appliances like air conditioners, washing machines, water and room heaters, deep freezers, and the like. Those that have these high-powered appliances cannot put them to effective use except with back-up generators owned by individual households.

However, the statistics obtained from the data (table 6) have revealed that far less than 15 percent of all appliances in use are energy efficient, except for the

Table 5
CORRELATION RESULTS (PRACTICAL BEHAVIOR RATING/SOCIAL STATUS)[a]

Spearman's rho	Practical Behavior Rating	Position in the Office (social status)
Practical behavior rating		
Correlation coefficient	1.000	.304[b]
Sig. (1-tailed)	-	.016
N	50	50
Position in the office (social status)		
Correlation coefficient	.304[b]	1.000
Sig. (1-tailed)	.016	-
N	50	50

[a]Spearman's rho correlation test statistics = 0.304, significant at 0.05 level for 1-tailed prediction. The p-value is 0.016 = 0.05 (is therefore significant); $r_s = 0.304$; N = 50; and $p < 0.05$.
[b]Correlation is significant at the 0.05 level (1-tailed).

lighting units—where there is a score of 19 percent and 15 percent for incandescent and fluorescent lighting efficiency, respectively. Even then, an anomaly is observed because there are no energy-efficient incandescent bulbs in circulation. This may be due to some respondents' lack of understanding of the difference between an incandescent bulb and a compact fluorescent lamp.

Among the three cluster units, it was observed that the responses from unit one—Abubakar Tafawa Balewa University Staff (ATBU) Quarters—was more pragmatic and reliable. This is probably because of the higher level of education, awareness, and social status characteristics manifested in that environment. Many respondents from the cluster unit three (Baluchi State Low-Cost Houses) are from the ''intermediate education'' group and have indicated firewood as the substitute for ''use of electricity'' in cooking. This is probably due to the high energy price, the low-powered and erratic nature of electricity supply, and their inability to acquire a back-up generator. Many of them equally lack the basic home appliances like electronics and computer hardware.

Findings and Conclusions

Similar to most survey research, the problem of access to respondents was eminent as many feared intrusion into their privacy and some were not willing to commit the time to responding to the surveys. This has led to some inadequate responses because of a lack of understanding of the dimension of study. However, an effort would be made in the larger study to have a prior interaction session before executing the questionnaires with the household respondents.

Table 6
PROFILE OF APPLIANCES IN USE[a]

S/No	Cluster Unit	ATBU Qrtrs	FPB Qrtrs	State L/Cost	Unit Sum	Total	Efficiency (in %)
1.	Sample size	16	12	22		50	
2.	Incandescent bulbs						
	Ordinary	137	74	100	311	386	19%
	Efficient	35	20	20	75		
3.	Fluorescent lamps						
	Ordinary	62	9	29	100	118	15%
	Efficient	5	7	6	18		
4.	Fans						
	Ordinary	84	54	82	220	237	7.2%
	Efficient	4	9	4	17		
5.	Air conditioners						
	Ordinary	18	10	21	49	56	12.5%
	Efficient	6	1	-	7		
6.	Water heater						
	Ordinary	19	11	23	53	54	1.9%
	Efficient	1	-	-	1		
7.	Water boiler						
	Ordinary	16	11	20	47	51	7.8%
	Efficient	1	1	2	4		
8.	Electric cooker						
	Ordinary	8	6	8	22	22	0%
	Efficient	-	-	-	-		
9.	Pressure cooker						
	Ordinary	1	2	9	12	13	7.7%
	Efficient	-	1	-	1		
10.	Electric stove						
	Ordinary	5	2	-	7	8	12.5%
	Efficient	-	1	-	1		
11.	Refrigerator						
	Ordinary	3	3	1	7	7	0%
	Efficient	-	-	-	-		

[a]ATBU Qrts = Abubakar Tafawa Balewa University Staff Quarters; FBP Qrts = Federal Polytechnic Bauchi Staff Quarters; and State Low/Cost = Bauchi State Low-Cost Housing Estate.

Though responses have indicated that a majority of those surveyed were conversant with the term "energy efficiency," not many are familiar with or aware of the actual implication in terms of its practice and benefits. This brings to the fore the confirmation of the hypothesis testing that indicated clearly the significance in the level of the relationship between practical behavior and the dependent variables of education, awareness, and social status; the level of awareness could

lead to practices but may not necessarily determine it due to attitude and cultural influences.

In terms of appliances, the knowledge of a majority of household respondents is limited only to lighting fittings. Even in this scenario, many do not know the difference between an incandescent bulb and compact fluorescent lighting in terms of energy consumption. As a result, almost all the appliances in use in all the cluster units are not energy efficient with the exception of the lighting unit, where about a 15-percent efficiency score is recorded for fluorescent lighting. However, the 19-percent score for the incandescent lamps is disregarded as there are no energy efficient incandescent lamps in circulation. Consequently, the majority of those respondents who have shown a concern for energy conservation are limited only to the practice of "switching off appliances when not in use" and a few others to "opening and closing of windows" due to climatic variation.

In short, human behavior in energy use in Nigerian households today is short of a considerable efficiency practice level necessary for an effective realization of the desired goal. Therefore, it is recommended that the government should institute a household energy-efficiency policy in which strategies for implementing and upholding efficiency practices by the housing stakeholders and occupants are explicitly spelled out. The government and the stakeholder professional bodies should further initiate regular information and awareness programs for the general public on energy-efficiency practices at a household level.

It is equally recommended that pilot studies of this nature be designed and undertaken with care and caution. The task to map out the study areas and locating the subject group should be accomplished prior to embarking on fieldwork. Research assistants and enumerators should be adequately trained and be accompanied in the field, at least on the first interaction/familiarization visit with the subjects. Finally, the pilot study tools or questionnaire should be reviewed adequately and updated with past similar studies, taking into consideration on-the-ground circumstances before the commencement of the larger study.

NOTES

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[3]Malcolm Bell, Robert Lowe, and Peter Roberts, eds., *Energy Efficiency in Housing* (Aldershot, United Kingdom: Ashgate Publishing Limited, 1996).

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[9]G. Gardner and P. C. Stern, op. cit.

[10]Ibid.

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[14]Ibid.

[15]Ibid.

[16]M. Hegger et al., op. cit.

[17]J. W. Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches,* 3rd ed. (London: Sage, 2009), and P. Nichols, *Social Survey Methods: A Field Guide for Development Workers* (Oxford: Oxfam 1991).

[18]J. W. Creswell, op. cit.

[19]Gillian A. Lancaster, Susanna Dodd, and Paula R. Williamson, "Design and Analysis of Pilot Studies: Recommendations for Good Practice," *Journal of Evaluation in Clinical Practice*, May 2004, pp. 307-12.

[20]Ibid.

[21]Public house ownership refers to housing accommodations provided by the government for the working staff. Private house ownership refers to houses owned by individuals/companies and rented to occupants. Personal ownership refers to houses owned by the individual occupants.

Proof Only