



## Assessment of Household Energy Efficiency In Ibadan, Nigeria

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### ABSTRACT

Households require significant amount of energy to meet various services like lighting, cooling, heating, cooking, refrigeration, electronic entertainment etc. There's virtually any household activity that can be carried out without the use energy. The requirement for household energy in Nigeria has been growing over time. There are various energy sources available to households in the country. They include fuel wood, charcoal, sawdust, gas, petrol, kerosene and electricity. It is fairly settled from literatures that electricity is the cheapest and cleanest energy source available. However, Nigeria, with a population of over 150 million people only has about 40% of its population having access to electricity with most of the people with access living in the urban centres (UNDP, 2011). Access to electricity in Nigeria is the dividing line between the urban areas and the rural areas. It can be said that Nigeria is suffering from "Energy Poverty". For a nation that seeks to attain the status of a developed economy, the issue of energy poverty must be resolved fast.

### 1.0 INTRODUCTION

Households require significant amount of energy to meet various services like lighting, cooling, heating, cooking, refrigeration, electronic entertainment etc. There's virtually any household activity that can be carried out without the use energy. The requirement for household energy in Nigeria has been growing over time. There are various energy sources available to households in the country. They include fuel wood, charcoal, sawdust, gas, petrol, kerosene and electricity. It is fairly settled from literatures that electricity is the cheapest and cleanest energy source available. However, Nigeria, with a population of over 150 million people only has about 40% of its population having access to electricity with most of the people with access living in the urban centers (UNDP, 2011). Access to electricity in Nigeria is the dividing line between the urban areas and the rural areas. It can be said that Nigeria is suffering from "Energy Poverty". For a nation that seeks to attain the status of a developed economy, the issue of energy poverty must be resolved fast.

The power currently generated in Nigeria is inadequate, unreliable and insufficient characterized by frequent voltage fluctuations and power outages that last several hours, days and in some cases weeks. According to Sambo (2008), the electricity demand in Nigeria far out strips supply and the supply is epileptic. The demand for power has continuously increased with the relative increase in population. Piqued by these situations, many households now rely on self-generation (using petrol or diesel generators) to complement or substitute the poor and unavailable grid supply. This is very expensive and source of air and noise pollutions. The country's electricity demand has continued to increase with relative increase in population with the utility company facing daunting challenges to meet the demand.

To address the crisis, the Government has set a target to increase the generation capacity to 10,000 MW in 2012 by building more thermal power plants across the country (UNDP, 2011). Increase in the generation capacity will provide great potentials for the country. However, the benefits of increased generation portend a threefold consequence viz: faster depletion rate of the country's energy resources (gas); increased cost of energy products and services as well as environmental degradation. Hence, energy



experts have identified Energy Efficiency as the safest, cheapest, cleanest and even the fastest means of generation.

Energy Efficiency (EE) refers to a reduction in the energy used for a given service (heating, cooling, lighting, etc) or level of activity (WEC, 2010). In other words, it is providing the same service with less amount of energy. This is only possible if the technology and practice/behavior (non technical factors) are improved. Energy Efficiency can be applied to various household energy usages, however, this study is limited to the application of energy efficiency to the management of household electricity consumption.

EE can be implemented from both the supply and demand sides. From the Supply Side, it entails the utility applying efficient technologies and equipment in the generation, transmission and distribution of electricity to consumers. While on the Demand Side it deals with employing technologies, appliances or practices to improve the use of energy at the level of the end users. This is also referred to as Demand Side Management. The utilities can on their part promote the end-user efficiency by devising and implementing techniques and technologies that ensure consumers use energy more efficiently. Examples include installation of smart meters at the residents of consumers to enable them track their energy consumption (Jessica & Christophe, 2010). Another way is by structuring the tariff in such a way that it encourages consumers to shift their consumption to off peak periods (CIPEC, 2002).

If EE is imbibed by households in Nigeria, it will lead to the following: Savings of personal income – home owners pay less as they consume less. More consumers will have access to energy – the energy saved in places with access to electricity can be sent to areas without access. Fewer generating plants would be needed; hence money needed for building more power stations will be spent on other competing sectors of the economy. Minimize impacts of generation on the environment. Energy resources are depletable; increased efficiency will guarantee their future sustainability and availability.

Household electricity use accounts for about 60% of the total electricity used in Nigeria. But the typical household wastes around one third of that energy yearly. This is mostly due to the use of inefficient appliances and indiscriminate consumption patterns. Thus, the energy saving potential of the residential sector is very high. Hence, this study intends to investigate means in which energy can be managed in households. The central purpose of this study is to identify and explain trends in energy efficiency performance for households in Ibadan, Nigeria. The specific objectives of the study are: (1) to identify technical and nontechnical (behavioural) measures to reduce energy consumption by households in Nigeria; (2) to suggest possible guidelines for the development of EE policies and measures in Nigeria.

## 2.0 METHODOLOGY

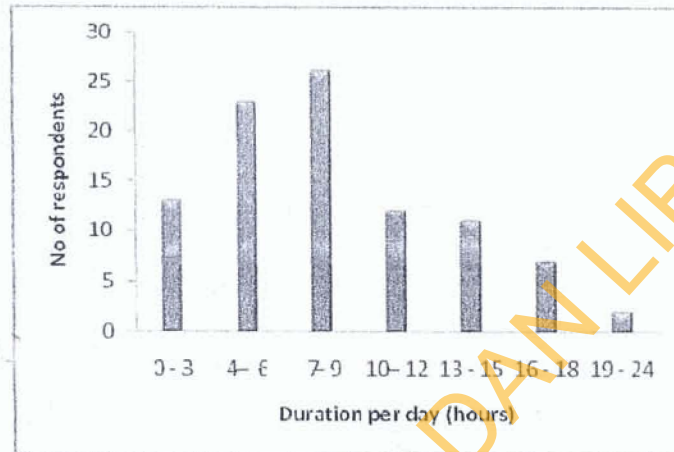
The study was conducted in the metropolitan area of Ibadan the capital city of Oyo state south-western Nigeria. The city is located between latitude  $7^{\circ}23'$  north of the equator and  $3^{\circ}23'$  east of the Greenwich meridian. It covers a total area of  $3080 \text{ km}^2$  and has a population of approximately 1,400,000. The Ibadan metropolis is divided by the PHCN into six business units. 15 households were randomly selected in each unit. This made a total of 90 households. Structured questionnaires were administered to obtain data from the 90 households. Data obtained were on technical and non-technical characteristics of electricity consumption by households. Other instruments used in the study are interview, physical survey and review of existing documents from relevant institutions. The data obtained were analyzed using the Microsoft Excel Statistical Software.



### 3.0 RESULTS AND DISCUSSION

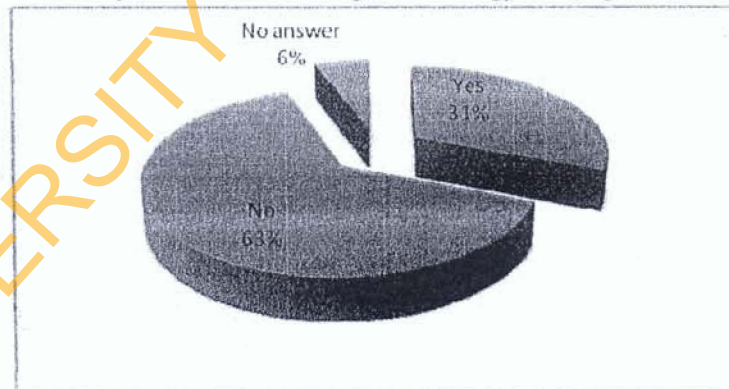
*General characteristics of households:*

*Duration of electricity supply:* power supply in the city is poor, 69% of the sampled household claim that they just have electricity supply between zero and nine hours per day (Figure 1). This is a likely situation in other cities in Nigeria. This is expected to affect the pattern in which households manage their energy.



**Figure 1:** Duration of electricity supply.  
**Source:** Field survey data.

*Management of household energy:* energy efficiency as defined is the simply the management of energy use to reduce wastage. When people do not know how to manage energy, it will eventually lead to wastage. The results revealed that about 63% of the sampled households do not know how to manage energy while 31% claimed they know how to manage their energy use (Figure 2).



**Figure 2:** Respondents response to the question “Do you know to manage energy in your home?”  
**Source:** Field survey data.

*Types of meter installed:* more than half of the sampled households (53.3%) have the analogue meter installed while 31.1% have the smart meter and 14.4% do not have any meter type installed (Figure 3).

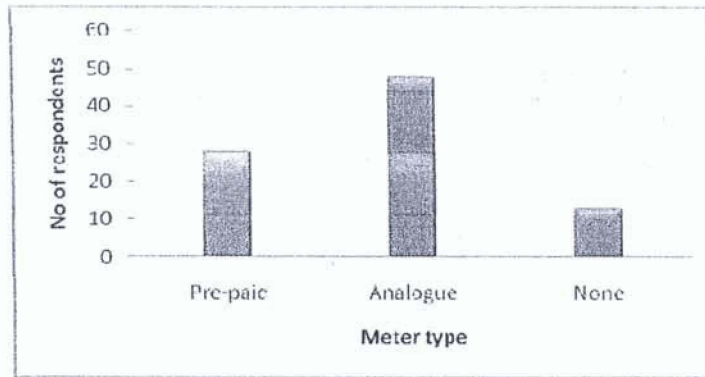


Figure 3: Types of meter installed in households.  
Source: Field survey data.

*Electricity bill satisfaction:* the results showed that 68% of the sampled households are not satisfied with their electricity bills while 33.3% are satisfied (Figure 4). Further findings shows that 90% of the respondents satisfied with their bills are those that have the smart meters installed in their homes.

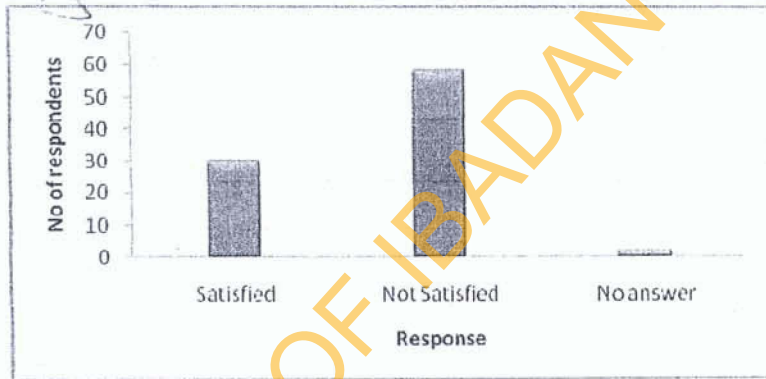
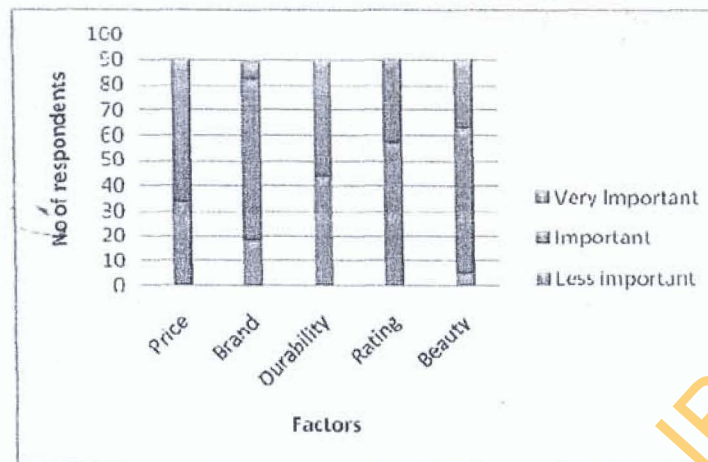


Figure 4: Household's electricity bill satisfaction.  
Source: Field survey data.

*Factors that influence choice of appliance:* lots of factors influence the choice of appliance a consumer purchase and use. Figure 5 revealed that price and durability are the most considered factors while appliance rating which should be highly considered is rather the least.



**Figure 5:** Factors that influences respondents' choice of appliances.

Source: Field survey data.

From the findings of the study, it can be seen that energy management and hence efficiency can be improved in households through technical and non-technical measures.

*Technical measures:*

These measures are not taken by the households directly but when put in place will alter the energy consumption pattern of households.

*Appliance labeling:*

Appliances represent the biggest residential electricity use growth area in the country due to the growth in population and increasing affordability of appliances (especially old second-hand appliances) that are inefficient. To reduce this trend and prevent Nigeria from becoming a dumping ground for such appliances, energy labeling programmes must be introduced. Labeling programmes are aimed at modifying the selection criteria of consumers by drawing their attention to the energy consumption of household appliances. Energy efficiency labels are informative labels fixed to appliances, indicating the appliance energy rating and performance. In some African countries like Ghana, South Africa, Egypt and Tunisia, energy labeling is now fully operational. Appliances that are commonly labeled include refrigerators, freezers and air conditionals and a range of other appliances such as rice cookers, water heaters, lighting products and washing machine. There are two main types of labels that can be placed on an appliance, endorsement labels and comparison labels.

Endorsement labels indicate that products belong to the "most energy efficient" class of products or meet a predetermined standard or eligibility criteria. This type of label merely informs users that the products meet certain required standard. An endorsement label may be specifically done for energy efficiency or it may be an "Eco label" (Harrington & Damnic, 2004).



the country (WEC, 2010). For example, Nigeria may decide to set a standard that refrigerators consuming more than 300kWh/yr will not be allowed into the country.

*Distribution of smart meters:*

The electricity metering system in the city is very poor. Lots of households are still using the old analogue meters that have become obsolete and many still do not any meter at all. To this end, many homes are placed on estimated bills and this does not promote energy efficiency. Since consumers know that they do not pay exactly for what they use, they will waste energy. The use of smart (prepaid) meters can help change the behaviour of consumers to use energy efficiently especially in the “face-to-face” type of housing. Hence, there should be massive distribution of the smart meters within the city. This will not only help households to track their energy usage but will also ensure consumers are charged on a ‘pay as you consume bases’.

*Providing financial incentives:*

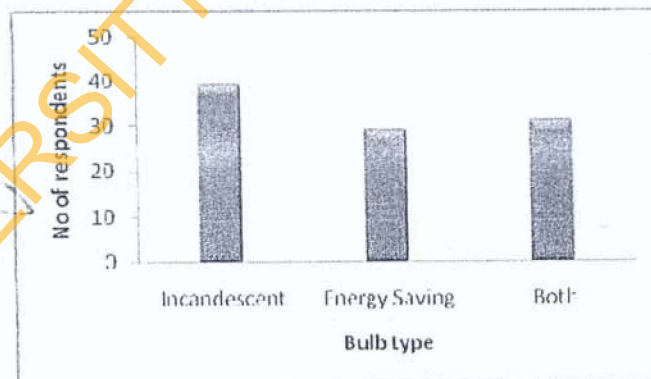
Providing incentives for purchasing energy efficiency products can used to change the behaviour of consumers to promote energy efficiency. This has been applied effectively in different parts of the world. In Nigeria, policy should be put in place to encourage people to switch from the use of less efficient to more efficient appliances. Furthermore, incentives should be given to local manufacturers and marketers of electrical appliances to encourage them to provide more energy efficient appliances.

*Non-technical measures:*

These are measures that can be taken directly by the households to manage their energy use efficiently. They are mainly changes in behaviours (energy consumption pattern) in order to reduce the energy wastage.

*Reduce the use of incandescent light bulbs:*

Most of the sampled households use the incandescent bulbs (Figure 8). Incandescent bulbs are very energy intensive. According to Lebot (2009), only about 5% of total energy used by an incandescent bulb is converted to light energy, the remaining 95% is converted to heat energy.



**Figure 8:** Types of bulbs used by households.

**Source:** Field survey data.

Energy consumption in these households can be reduced if incandescent bulbs are replaced with energy saving bulbs like compact fluorescent lights (CFL). The rating of incandescent bulbs range from 40W to



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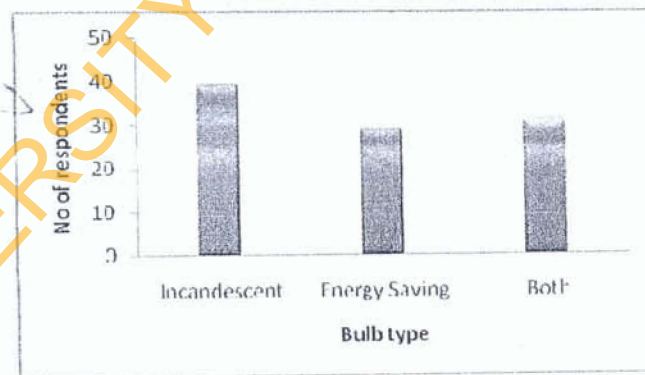
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The various agencies charged with the responsibilities for developing and enforcing standards should be adequately empowered to coordinate and monitor the implementation of energy efficiency policies.

The National Centres for Energy Research should collaborate with the universities of technologies in the country for knowledge and research sharing to help the development of energy efficiency technologies in Nigeria.

Government should set up a national fund for the promotion of energy efficiency in the country.

Standards and labeling programmes should be introduced to establish national standards and labels for Nigeria. This is to enable consumers identify energy efficient appliances.

Policy should be set to reduce/eliminate the importation of old and inefficient second-hand appliances into the country.

Prepaid (smart) meters should be distributed to households to allow them properly track and manage their energy usage.

Awareness programmes should be planned to enlighten the citizenry on the benefits of energy efficiency.

#### 4.0 CONCLUSION

It is a truism that energy is the cog that drives the wheel of the economy of any nation. The greater the amount of energy available, the faster the wheel turns. While EE is the lubricant that can be applied to the cog to enable it run smoothly. Thus, EE can be employed as a key driver of sustainable development for any nation's economy. Employing EE strategies in Nigeria will address a variety of objectives, including reduction of wastage, reduced investment need in generation and environmental protection (local pollution and deforestation):

By reducing the amount of energy consumed by households, EE can be the main strategy for increasing the availability of energy within the country. It is an energy source generated from the "would have been otherwise wasted" resources. Every kWh saved is equal to kWh generated and it is easier to save than to generate.

EE will help reduce the huge need of investment for expanding energy infrastructure, thereby freeing capital for other purposes or avoiding shortages of capital that limits economic growth; more generally, it will enhance economic development by reducing energy shortages and contribute to poverty eradication.

It will contribute to environmental protection by reducing local pollution and deforestation in particular, especially in rural areas where many households still do not have access to electricity and have to rely on fuel wood.

#### REFERENCES

- CIPEC (2002). *Energy Efficiency Planning and Management Guide*. A publication of Canadian Industry Program for Energy Conservation. [www.oee.nrcan.gc.ca](http://www.oee.nrcan.gc.ca)
- CREDC (2009). *Energy Efficiency Survey in Nigeria*. A publication of Community Research and Development Centre. [www.credcentre.org](http://www.credcentre.org)
- Harrington L. and Damnic M. (2004). *Energy Labelling and Standards Programme Throughout the World*. A publication of the National Appliance and Equipment Energy Efficiency Committee, Australia. NAEEEC Report 2004/04
- Jessica S. And Christophe D. (2010). *Evaluation of Residential Smart Meter Policies: WEC-ADEME Case Studies on Energy Efficiency Measures and Policies*. Published by VaasaETT Global Energy Think Tank.





Lebot, B. (2009). *Energy Efficiency and Market Transformation: A Short Overview of Best Practices*. A paper presented during the Inception Workshop of the UNDP-GEF Project to Promote Energy Efficiency in Residential and Public Building in Nigeria, 14th July 2009.

Sambo, A.S. 2008. *Matching supply with demand*. Paper presented at the National Workshop on the Participation of State Governments in the Power Sector, 29 July, Ladi Kwali Hall, Sheraton Hotel and Towers, Abuja.

UNDP, 2011. *Project Inception Report: Promoting Energy Efficiency in Residential and Public Sector in Nigeria*. United Nations Development Programme (UNDP) Nigeria, May 2011.

WEC (2010). *Energy Efficiency: A Recipe for Success*. A publication of World Energy Council. [www.worldenergy.org](http://www.worldenergy.org)

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