

Energy Efficiency Survey in Nigeria

A Guide for Developing Policy and
Legislation



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Published in September 2009

This project was made possible by the financial support from the International Rivers, USA. The views expressed in this book do not necessarily imply those of the International Rivers.



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Acknowledgements

The Community Research and Development Centre is grateful to the International Rivers for providing financial support to the project. Our particular gratitude goes to Terri Hathaway and Lori Pottinger for their inputs and all their support. Benoit Lebot of the UNDP is appreciated for all his intellectual investment in our colleague. Rev. Nnimmo Bassey is appreciated for all his contributions. Our profound gratitude is also expressed to Dr. Victor Fodeke, Head of the Special Climate Change Unit, Federal Ministry of Environment, Nigeria for all his support to our activities. To all stakeholders who contributed to the success of this project, we say thank you.

Abbreviations

AR4	Fourth Assessment Report of the IPCC
CFLs	Compact fluorescent lamps
CREDC	Community Research and Development Centre
ECN	Energy Commission of Nigeria
EE	Energy Efficiency
FCT	Federal Capital Territory
GHGs	Greenhouse gases
IPCC	Intergovernmental Panel on Climate Change
m/s	meter/second
MEPS	Minimum energy performance standards
MW	Megawatts
OECD	Organization for Economic Corporation and Development
PHCN	Power Holding Company of Nigeria
RE	Renewable Energy
RETs	Renewable energy technologies
S&L	Standards and Labels
W/h	Watt per hour
UNDP	United Nations Development Programme

Preface

Reducing the impacts of the use of energy has been described as one of the key technical, political and moral challenges facing the world today. While the world works towards the use of cleaner energy, our priority should be to use the energy we generate more efficiently. According to a publication by the International Rivers, energy efficiency measures are cheaper, cleaner and faster to install than any other energy options. Energy efficiency measures have the potential to promote economic development and can lead to job creation and saving of personal income. More also, energy efficiency will play a pivotal role in the mitigation of climate change; a large part of the greenhouse gases emitted into the atmosphere come from energy generation. This assertion is contained in the Fourth Assessment Report (AR4) of the Intergovernmental Panel on Climate Change (IPCC), which has demonstrated that improved energy efficiency will play a key role in our mitigation of climate change.

In Nigeria, experts have asserted that Nigeria can save up to half of the energy currently consumed in the country if energy is efficiently utilized. The major challenge has been that energy policy in Nigeria has undermined the importance and gains of energy efficiency to the environment and economic growth. In the midst of the prevailing energy crisis in Nigeria, energy efficiency will play a pivotal role in ensuring access to energy. Efficiency is not only cheaper than all other options; it also leads to growth in jobs and personal income. By reducing energy bills, it frees up money that can be spent elsewhere in the economy.

It appears that the concept of energy efficiency seems to be poorly developed in Nigeria. Having discovered the policy gaps in the Nigerian system on energy efficiency, the Community Research and Development Centre designed and embarked on a research that will help to provide guideline for developing policy and legislation in the energy sector. We discovered that there is absence of research materials and data that will guide and strengthen regulatory measures to use energy efficiently in Nigeria. Hence the research was embarked upon to elicit information that will guide the development of energy efficiency policy which will in turn strengthen regulatory measures to use energy efficiently in Nigeria. In this study, we are focusing on the management of electricity; though energy efficiency is applicable to other forms of energy.

Another objective of the study is to identify commercially and behaviorally low-cost ways of reducing energy consumption in the residential, public and private sectors in Nigeria. The information from this study, we believe will help to develop energy efficiency policy document applicable in Nigeria. The research will also help to identify renewable energy potential in the different regions of Nigeria. This document will also serve as a training manual for conferences and workshops.

CHAPTER ONE

Introduction

What is Energy Efficiency?

Energy is very important in everything that we do. Without energy there is virtually nothing we can do. All the things we need to do on daily basis, we need energy to do them. The same way, just as man cannot do without energy, no country can develop without energy. We need energy for domestic, agricultural, industrial, commercial and official activities. Access to energy is the dividing line between the poor countries and the rich countries. This explains why the developed countries of the world have and consume far more energy than the developing and underdeveloped countries. If any country must tackle the problem of poverty, the country will need to provide energy for her citizens.

Energy efficiency does not mean that we should not use energy, but we should use energy in a manner that will minimize the amount of energy needed to provide services. This is possible if we improve in **practices** and **products** that we use. If we use energy efficient appliances, it will help to reduce the energy necessary to provide services like lighting, cooling, heating, manufacturing, cooking, transport, entertainment etc. Hence, energy efficiency products essentially help to do more work with less energy. For instance, to light a room with an incandescent light bulb of 60 W for one hour requires 60 W/h (that is 60 watts per hour). A compact fluorescent light bulb would provide the same or better light at 11 W and only use 11 W/h. This means that 49 W (82% of energy) is saved for each hour the light is turned on.

When we talk about **end-use efficiency**, we refer to technologies, appliances or practices that improve the efficient use of energy at the level of the final user. For example the appliances we use in our houses and offices. Though this term is not limited to electrical appliances, it can also be used for other areas of efficiency such as measures to improve the ability of houses to absorb and retain heat in winter and keep out heat in the summer. On the side of utility companies, providing electricity, they can also device ways and technologies to promote the efficient use of energy. This is referred to **demand-side efficiency** or **management**. Demand-side management can be policies implemented by utilities and energy planners that encourage consumers to use energy more efficiently. An example of this is load shifting, which include encouraging consumers to move their energy use away from peak period.

As we can see so far, there are two important ways we can approach the efficient use of energy. The first one is the **technological approach** while the second is the **behavioral approach**. For the technological approach, we need to change the type of technology we use to a more efficient one. A good example is the one we cited above on the light bulbs; replacing incandescent bulbs with energy efficiency bulbs. The behavioral approach entails

changing the ways we do things. An example is switching off appliances when not in use. Many of these behaviors will be discussed in the next chapter.

Importance of Energy Efficiency

Energy efficiency has become the key driver of sustainable development in many economies in the world. If we use energy efficiently, it will lead to the saving of personal income; families will not have to spend so much money paying for energy. It will help to reduce the building of more power stations, thus the money for building power stations will then be spent on other sectors of the economy. More also, more people will have access to energy; if we save energy in one part of the country, the energy saved can be made available in another part. In Nigeria, where the utility companies do not have enough energy to meet the needs of everybody at the same time, energy supply is alternated. With good energy management at the residential, public and private sector, there will be no need to alternate electricity supply.

Most of the energy we generate in Nigeria comes from the burning of fossil fuel (oil and gas). For every kilowatt of electricity we consume, there is an equivalent emission of greenhouse gases (GHGs). Energy efficiency can help to reduce the emission of GHGs and reduce the reliance on petroleum to drive our economy. The negative environmental impacts associated with the generation of energy will also be reduced if we use energy efficiently. Many people can be employed during intervention programmes to change the behavior of people to use energy efficiently. For companies manufacturing electrical appliances, there will then be competition among them on who manufactures the most efficient appliances to capture the patronage of consumers.

Status of Electricity Generation in Nigeria

From 2008 ECN report, there are nine electricity generating stations in Nigeria. Three of these stations are hydro based while six are thermal based and they are all owned by the government under the Power Holding Company of Nigeria (PHCN). All of them have an installed capacity of 6000MW. However, for many reasons ranging from shortage of gas supply to lack of maintenance, these stations are performing far below the installed capacity. From the recent figure, Nigeria is generating 2000MW of electricity (Punch, September 11 2009). Part of the electricity generated is exported to neighboring Niger Republic. Electricity demand in Nigeria is very high as about 60% of Nigerians do not have access to electricity. Although many gas-powered stations have been commissioned to increase generation by 4000MW, this will still not be enough. We can see that the energy generated in Nigeria is grossly inadequate, hence the need to imbibe energy efficiency culture.

Justification for the Study

Energy policies in many developing countries including Nigeria have not really put into consideration the importance and gains of energy efficiency to the environment and

economic development. This could be that the concept is poorly developed in these countries. In many developing countries, there is inadequate data that will guide the development of policy which will strengthen regulatory measures to use energy efficiently. The research was conducted to elicit information that will guide the development of policy and legislation which will strengthen regulatory measures to use energy efficiently in Nigeria. In this study, our focus is in the management of electrical energy.

Objectives of Study

- To elicit information that will serve as a guide to draft policy that will strengthen regulatory measures to use energy more efficiently in Nigeria.
- To identify commercially and behaviorally low-cost ways of reducing energy consumption in the residential, public and private sectors in Nigeria
- To identify renewable energy potentials in the different regions of Nigeria

Method of Study

Methods used during the study included the use of questionnaires, focused group discussions, interview with key informants, physical survey and review of existing documents from relevant agencies and academic institutions. All our respondents were drawn from the urban areas, the reason being that these places have access to electricity. The study was conducted in three major cities in Nigeria – Lagos, Benin City and the Federal Capital Territory, Abuja.



Fig. 1.0: Map of Nigeria (arrows pointing to study locations)

A total of 150 respondents were randomly selected in these cities and interviewed. Data were subjected to statistical analysis using the appropriate statistical packages.

CHAPTER TWO

Energy Intensive Behaviors in Nigeria

We mentioned in the previous chapter that one of the ways to tackle the inefficient use of energy is to change our behaviors. From our study, we found out that a lot of energy is wasted in Nigeria because households, public and private offices and industries use more energy than is actually necessary to fulfill their needs. One of the reasons is that they use old and inefficient equipment and production processes. The other reason, which we want to discuss in this chapter are unwholesome practices that lead to energy wastage. In this chapter, we will enumerate these practices.

Dominant Use of Incandescent Light Bulbs

The common name for incandescent bulb in Nigeria is “yellow bulb” because of the yellowish color of the light rays from the bulbs. Many Nigerians are not familiar with the name ‘incandescent’. This could be the reason why 10% of respondents did not provide any answer. From our study, 65% of our respondents claim they use incandescent bulbs (Fig. 2.1). The use of incandescent bulbs for lighting is energy intensive. Only about 5% of total energy used by an incandescent bulb is converted light energy, the remaining 95% is converted to heat energy (Lebot, 2009). The energy rating of the incandescent bulbs found in the Nigerian market range from 40W to 200W, thus we have the ones for 40W, 60W, 100W and 200W.

Our findings revealed that in many places where people experience low voltage, people purchase the 100W and 200W in order to get a brighter effect. Also, many people use the high rating incandescent bulbs for outdoor lighting because they appear brighter. A major factor working against the shift from incandescent bulbs to energy saving bulbs is the cost. Energy saving bulbs are far more expensive than incandescent bulbs. The cost of energy saving bulb in the Nigerian market ranges between N800 to N1000. However, some substandard energy saving bulbs could be purchase for about N200. On the other hand, the prices of incandescent bulbs range from N30 to N100.

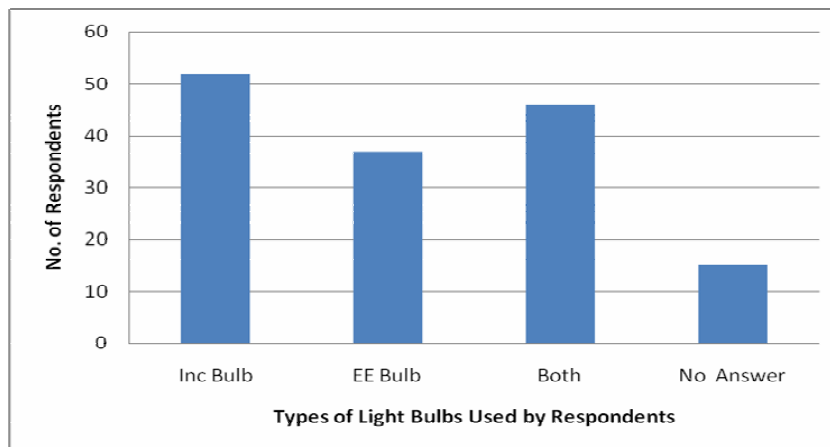


Fig. 2.1: Chart showing the types of light bulbs use by respondents

Energy consumed in Nigeria can be drastically reduced if Nigerians replace their incandescent bulbs with energy efficiency bulbs. The energy saving bulbs we found in the market were those of 20W, 26W and 36W. If a particular household using 20 incandescent bulbs of 60W decides to replace them with energy saving bulbs of 20W, instead of spending 1200W/h (20 x 60W) for lighting, they will be spending 400 watts per hour (20 x 20W). Thus this saves approximately 67% of energy for lighting alone. This is a huge saving. On a larger scale, if Nigeria as a country phase out one million incandescent bulbs and replace them with energy saving bulbs, the country will be saving about 40MW of electricity. This is enough to provide electricity to many communities in Nigeria. If each of the 36 states and the FCT replace one million incandescent bulbs each, we can save up to 1480MW of electricity.

Policy option for Nigeria will include phase out of incandescent bulbs from the Nigerian system and putting a ban on the importation and production of incandescent bulbs. Policy to encourage the importation and production of energy efficiency light bulbs will enhance the efficient use of energy. Government should put in place strategies to reduce the cost of energy saving bulbs. Awareness creation is also needed to change the attitude of Nigerians on the need to save energy by using the right technology.

Putting on Light to Advertise Goods

Many people that sell certain goods such snack and electrical materials switch on light during the day to draw the attention of people to by their goods. The same way, operators of fast food centers do the similar thing; they use incandescent bulbs to heat their food and at the same time draw the attention of people to their products. This practice is energy intensive and should be discouraged. In some of the fast food centers, several incandescent bulbs are put on at the same time for aesthetic purpose and to create illumination during the day. These houses could have been built in a way that they use the natural light during the day. In one of the fast food center we visited, the counted about 30 incandescent bulbs being used at the same time during the day.

Policy option is that government should place tax on energy consumption for industries and privately own firms. It should be made mandatory for these private institutions to carry out energy audit and make them public in order for the designated agency to place tax on them. The energy audit should be done by government designated agencies or firm for transparency. Designs for houses should be properly screened by designated government agency to ensure it complies with energy efficiency standards of building houses. It should be made mandatory for medium and large privately owned firms to have Energy Management Unit before they are registered by government

Switching on Outdoor Lighting during the Day

Our study revealed that many Nigerians do not put off their outdoor lighting during the day. This is particularly very common in commercial and residential areas in many major cities in

Nigeria. Even in public institutions such as universities, government ministries were also found to have their outdoor lighting switched on during the day. Many respondents blame the PHCN for this behavior. According to them, when there is power outage during the dark hours of the day and it lingers into the day, they forget to put off their outdoor lighting. A lot of energy can be saved if Nigerians cultivate the habit of putting off their outdoor lighting in the day time. Energy saved from using the natural light instead of light bulbs during the day can be made available for use in offices and for industrial activities.

Policy should be made to make it mandatory for occupants of residential, public and private buildings to put off their security light during the day. There may be need to make legislations in order to penalize any defaulter.

Proliferation of Private Water Boreholes

In many major cities in Nigeria, many people now have boreholes in their houses. This arises because of the inability of government to provide water in many parts of the country. The use of privately owned boreholes is on the increase. In many cases, you find two or more boreholes in one street. The machine for pumping water from the aquifer is an energy intensive machine and can consume up to 2000W of electricity. Apart from consuming a lot of energy, these machines exert a lot of stress on PHCN facilities. In many parts of the world, water is conveyed from a central system through network of pipes to residential, public and private buildings. With this method, the energy used to take water from the ground and make it available to the people is greatly minimized.

Access to water is the right of the people and it is the responsibility of government to consistently provide water for her citizens. This is the best way to discourage the use of private boreholes. A lot of energy will be saved if government and accredited private companies provide water from a central system. Policy should be made to encourage a centralized system of providing water.

Industrial Activities in Residential Areas

Many cities in Nigeria are not properly planned. The practice of building industries in residential areas is unhealthy for power supply for residential use. With this kind of practice, utilities providing electricity are not able to plan on how to allocate energy to the various sectors. More also, because of the high energy consumption of the equipment used in the industries, the equipment exert so much stress on the PHCN facilities which were initially installed to serve residential areas. In this kind of system, it is difficult to allocate energy for the two sectors in a way to maximally satisfy everybody. It is also difficult for utilities to do load shifting, which we earlier described in Chapter One.

Policy should be made to encourage the proper planning of cities, so that residential and industrial areas are separated. This will help the government to plan how they can effectively provide electricity for the two sectors.

Setting Appliances on Standby Mode

Many people do not know that if you leave your appliances on standby mode, the appliances still consume energy. Putting an electrical appliance on standby mode is not the same thing as putting it off. Electrical equipment consumes energy when on standby mode. Although the energy they consume is not the same as when they are switched on, but putting them off when not in use can save some measure of energy. Consumers should be appropriately informed by the manufacturers of the energy electrical appliances at standby mode. A good way to do this is to inscribe it on a label and stick them to the appliances.

Government should make policy to ensure that energy labels are comprehensive enough to provide adequate information to consumers.

Simultaneous Use of Multiple Appliances in Public Buildings

This is a very common practice among public officers in Nigeria, especially the senior staff. In one department or building, you will find refrigerators and air conditioners at the same time in all offices, even those of junior staff. It is a common practice to find out that in government offices, you will find a refrigerator, air conditioner, television set, photocopy machine, desktop computers, fans, electric kettle and incandescent bulbs, and in many cases these appliances are switched on at the same time. You go to another office in the same department or building, you find similar things. The reason for this practice could be that public officers do not pay individually for electricity and thus they are not conscious of the way they use energy. Our findings revealed that many government buildings are not metered; thus government officers are not accountable to the energy they use during office hours.

We also find out that in university hostels, occupants use all kind of electrical materials and they do not have restriction on the kind of equipment they use. It is a common practice for students to use all kind of electrical heating equipment for cooking in student hostels. The use of particular heating equipment popularly call "hot plate" in student hostels is very energy intensive and should be discouraged. Individual rooms in student hostels are not metered; this encourages wastage as they are not held accountable for the energy they use.

Policy should be made to make public officers and users of public building accountable to the energy they spend. Public and private institutions should develop their own energy management policy that will restrict the use of certain appliances. It should also be made mandatory for public and private building to carry out energy audit and make the details available to the public domain. Policy and legislation should be made to place a tax on energy consumption in public and private institutions. Policy should be developed to encourage the use of central air conditioning system instead the use of individual air conditioners



Plate 2.1: “Hot Plate”

Leaving Appliance on when not in Use

Our findings revealed that many Nigerian do not put off their appliances when they are not in use. This practice can lead to significant wastage of energy in residential, private and public buildings. The reason for this could be that many Nigerians do not really pay for the electricity they consume. In many houses, the meters installed by PHCN are no longer functioning. What PHCN officials do is to place these houses on estimated bill. This practice encourages the wastage of electricity, since they do not really account for what they consume. When people are placed on estimated bill, people are either overcharged or undercharge. One of the respondents testified that before they were given the new prepaid meter, PHCH was charging them over N2500 per month, but when the new meter was installed, they spend about N400 per month. This is a case of overcharged. Again, with estimated bill, during protracted power outage, people still pay for what they do not consume.

Policy should focus on encouraging the use of prepaid meter and the practice of using estimate bill should be discouraged.

Multiple Use of Inefficient Heating Equipment

The use of heating equipment for cooking and heating water should be discouraged in the residential and private buildings. Government should encourage the use of solar heaters. Heating equipment consume about 60% of the energy used in houses. In places like hotels where several water heating equipment are installed in several rooms sometime numbering up to 100 rooms or more, the use of solar heaters in these buildings will help to save a lot of energy.

Government should make policy that will encourage operators of hotels to use solar heaters instead of electricity. This could be in the form of tax reduction or compensation for being

energy efficient. The less energy efficient one can be penalized and made to pay certain fine which will be used to encourage the more efficient ones.

Purchase of Secondhand Appliances

The Nigerian market is flooded with all kinds of secondhand appliances. Over 90% of Nigerian use one secondhand product or the other. They are cheaper compared to the new ones. Many Nigerians are on the opinion that secondhand products are more durable than the new ones. This assertion could be based on the fact that there are a lot of substandard goods in the market and the secondhand goods tend to last longer than them. Many of the secondhand products come from European and North American countries and they may have been manufactured long time ago. The efficiency of these products is quite doubtful and the possibility exists that they may have been rejected by the former users to purchase more recent and efficient appliances. The secondhand market need to be further studied to direct policy that will address the situation.

Policy to standardize the secondhand product imported into the country is necessary. There is also need to make policy that will encourage Nigerians to purchase new and modern appliances.

Barriers to Energy Efficiency Development in Nigeria

It was identified that the following are barriers to the development of energy efficiency in Nigeria:

Lack of Policy and Legislation: Lack of policy and legislation to address the inefficient use of energy is a very key barrier to the development of energy efficiency. Policy and legislation will help to change behavior towards an energy efficient economy. From our study, 79% of respondents are not aware of any policy on energy efficiency made by government (Fig. 2.2). Private and public institutions should also be encouraged to make their own policy to promote the efficient use of energy. The government can make it mandatory for public, large and small scale private organizations to establish an energy management department or unit.

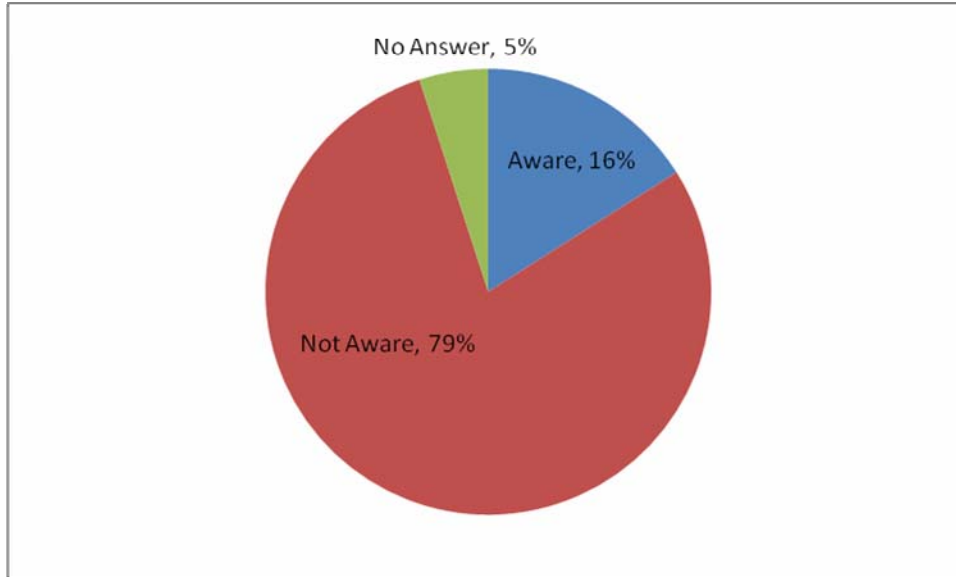


Fig. 2.2: Pie chart showing how aware our respondents are of any energy efficiency policy

Lack of Awareness: From our study, many of our respondents are familiar with the term “energy efficiency”, 68% of respondents claimed that they are familiar with the term. However, many of these one who claim they are familiar with the term could not really define it properly. Awareness creation will go a long way to help people understand the concept and change their behavior.

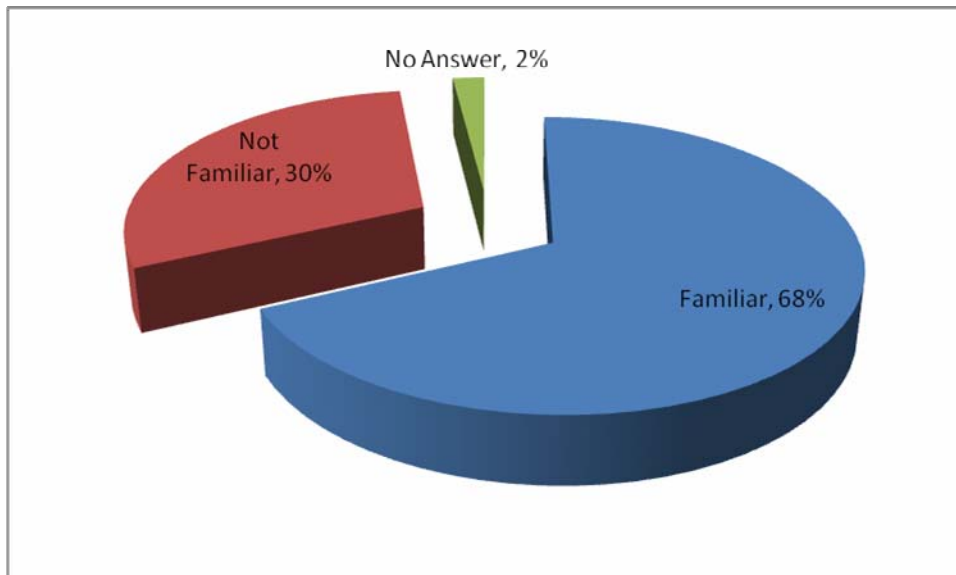


Fig. 2.3: Pie chart showing how familiar our respondents are with the term “energy efficiency”

Lack of Trained Personnel and Energy Efficiency Professionals: Inadequate trained personnel and professional is another factor inhibiting the development of energy efficiency. A total of 77% of our respondents said that no member of their offices has been trained on energy management. Nigeria as a country lack adequate energy efficiency experts that will drive the development of the concept and policy that will promote energy efficiency. The Figure below (Fig. 2.4) shows the response to the question “if any member of your office had been trained on energy management”.

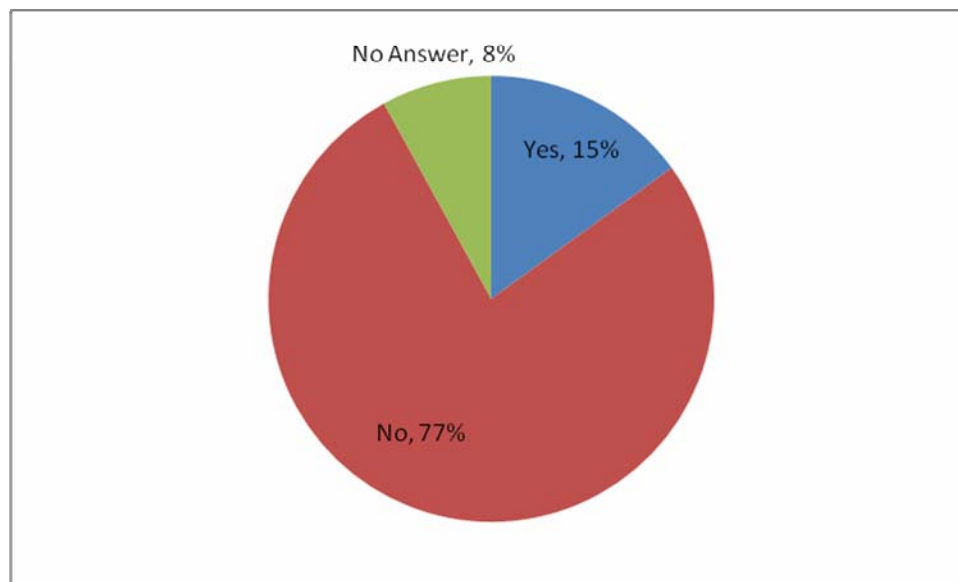


Fig. 2.4: Pie chart showing the response to the question “Has any member of your office been train on energy management?”

Importation of Used Machines: As we have mentioned earlier, the proliferation of imported secondhand appliances may hinder the use of efficient appliances. The reason is that these secondhand equipment are cheap and easily available, the new and efficient ones may be unable to compete with them in the market

Lack of Research Materials on Energy Efficiency: There is lack of research materials and data that will guide the development of policy that will strengthen the efficient use of energy. Also there is lack of material to conduct training on energy efficiency. These barriers are being addressed by this study.

Inefficient Metering System and Low Electricity Pricing: The metering system in Nigeria is very inefficient and does not encourage consumers to pay the correct amount for the energy they consume. Many people that still use the old meters are now on estimation since these

meters are faulty. The use of prepaid meters which was recently introduced by the PHCN will help change the behavior of consumers to use energy efficiently.

Proliferation of Inefficient Equipment and Desire to Minimize Initial Cost: The desire to minimize initial cost force many consumers to purchase cheap and inefficient appliances. For example, the cost of energy saving bulbs in the Nigerian market is about N800 compared to an incandescent bulb which cost about N40. Many consumers will prefer to go for the cheaper ones not minding the long-term benefit of using efficiency bulbs.

Low income: About 70% of Nigerians live below the poverty line of \$2 per day. Many are not able to afford the cost of efficiency appliances which are sometime more expensive than the less efficient ones.

CHAPTER THREE

Factors Influencing Consumers Choice of Appliances

In this chapter, we will discuss in details some of the factors that consumer consider before they purchase any appliance. First, it will be good we look at Nigerians' perception of the entire concept of energy efficiency. As we mentioned earlier, although many of our respondents are familiar with the term "energy efficiency", some seem not to fully understand what it entails. They were not able to correctly define the concept. A good understanding of the concept will help end users of electricity to become conscious of the way the use energy. Our study revealed that 71% of our respondents claimed that they do not know how to carry out energy audit in their homes and offices (Fig. 3.1). This may suggest that many people do not bother to check the energy an appliance consumes before purchasing one.

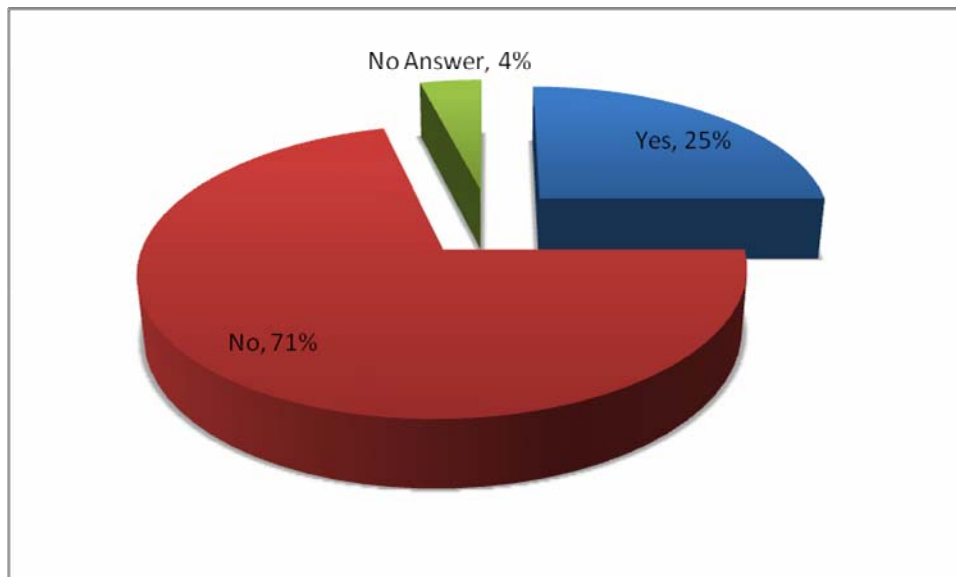


Fig. 3.1: Pie chart showing the response to the question "Do you know how you can carry out energy audit?"

Access to electricity is a problem in Nigeria, 99% of our respondents do not get electricity supply for up to 24 hours. This is another important factor that may affect the development of energy efficiency. "You are asking us to save energy; we do not even have the energy to save". This is one of the comments we received during one of our focused group discussion. Respondents are on the opinion that when the energy is made available, then they will endeavor to save energy. Awareness creation and enlightenment campaign is needed to erase this notion from the minds of Nigerians. People should be made to understand that if

they save energy, there will be enough energy to go round everybody. This can help to solve the epileptic supply of electricity.

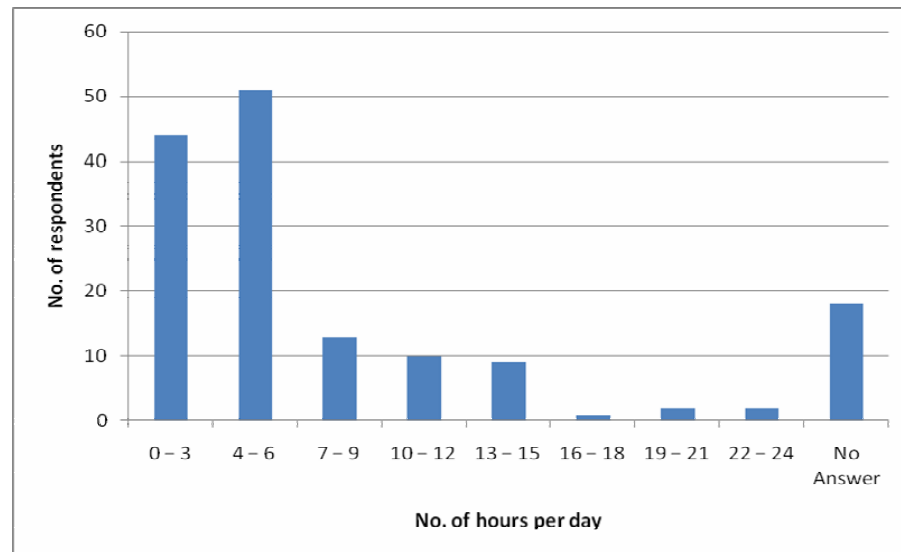


Fig. 3.2: Bar chart showing the number of hours respondents get electricity supply per day

When purchasing any appliance, there are so many things consumers consider. A better understanding of these factors could help to make policy to promote energy efficiency. Government can take advantage of these factors to develop policy that will promote energy efficiency. Some of the factors identified during the study are listed below:

- Beauty of the appliances
- The price of the appliance
- The manufacturer's name
- The price of the appliance
- Durability
- The need for the appliance
- Efficiency of the appliance
- Maintenance cost/ease of repair
- Consumer rating
- Quality of the appliance
- Performance output
- Provision of warranty

Beauty of the Appliance: A total of 35% (Table 3.1) of our respondents stated that they look out for the beauty when purchasing any appliance. The most beautiful equipment may not be the most efficient in terms of energy consumption. Equipment that is beautiful and very

attractive to the eye may also be very expensive compared to the one that is less attractive. A better understanding of this factors and how it relates to consumers behavior is important in the crusade to change consumer's behavior towards imbibing energy efficient culture.

Table 3.1: Factors influencing consumer's choice of appliances

Factors	Beauty	Manufacturer	size	Energy Rating	Price	Others
% of respondents	35%	68%	16%	47%	51%	17%

Price of the Appliance: Price is a very strong economic factor influencing the demand for goods and services. A large number of our respondents 51% agreed that they consider the price of an appliance before they purchase one. This will be a very good tool to influence the behavior of consumers to purchase more efficient appliance. Even if the prices of less efficient appliances are low compared to the more efficient ones, government can come up with policy that will encourage people to go for the more efficient ones.

Size of the Appliances: Only few of our respondents consider the size of the appliances before making purchases; 16% of our respondents claimed that they consider the size. Our finding revealed that the size do not necessarily mean that it consumes more energy, the same way the smaller the appliance does not mean that it consumes less energy. Consumers should be enlightened to know this fact.

The Product/Manufacturer's Name: From our survey, 68% of our respondents purchase their appliance putting into consideration the manufacturer of the appliance. This is another very strong factor influencing consumer's choice of appliances. Many consumers believed that the products of certain manufacturers are more durable than others. Irrespective of the price of these appliances, the consumers go for these products thinking that it will last longer and are of better quality. This assumption may not always be correct. Many dubious traders have taken advantage of this notion to exploit consumers. Dealers on electrical materials capitalize on this factor to deceive their consumers to think that they are buying from the manufacturer they cherish.

The Amount of Energy an Appliance Consume: Only 47% of our respondents stated that they take this factor into consideration. As stated earlier, 71% of our respondents do not know how to access this information from their electronics. Consumers should be enlightened on how to access this information. Manufacturers of electrical appliances should device ways of making this information more vivid for consumers to access.

Durability: Some the respondents claimed that they also look at the durability of any appliance before buying it. This is also linked to the product name or manufacturer. We do

not know how they can precisely determine the durability of any product at the time of purchase.

The Need for the Appliance: Some of our respondents make their choice based on how important the appliance is to them. They will like to ask the question "Do I need the appliance now?"

Efficiency of the Appliance: Some others consider the efficiency of the appliance before they purchase one. Here in Nigeria, the government is yet to come with standards for determining the efficiency of the various appliances. Policy is needed to address this. Again, the Standard Organization of Nigeria should be properly equipped to define energy efficiency standards.

Maintenance Cost/Ease of Repair: Many people would want to buy appliance that are serviceable and less expensive to maintain.

Consumer Rating: Some people are influenced by the general perception about an appliance. They believe that the more people accept a product, the better the product. This is another factor that influences consumers' choice of appliances.

Quality of the Appliance: Some of our respondents said they consider the quality of appliances. Again, we still wonder how they are able to determine this at the time of purchase.

Performance Output: Some respondents said they consider the output of the product before they purchase. Again, they also consider the number of functions the product is able to display.

Provision of Warranty: Provision of warranty is another factor that consumers put into consideration when they are purchasing appliances.

CHAPTER FOUR

Best Practices in Energy Efficiency

This chapter will look at best practices in energy efficiency from other parts of the world and looks at the possibility of domesticating some of these practices in Nigeria. The practices discussed in this chapter are in no way exhaustive.

Standard and Label (S&L)

In many countries of the world, especially the industrialize nations, the use of **standards and labels** (S&L) are increasingly becoming common. An energy label is attached to electrical appliance to display the accurate energy consumption information on the product, such information will help the buyer to take decision whether to buy the product or not. Energy label will provide information on the amount of energy an appliance consumes and will also tell the consumer how efficient the appliance is. In many of the OECD countries, energy labeling is now fully operational and the appliances that are commonly labeled include refrigerators, freezers and air conditionals and a range of other appliances such as rice cookers, boilers, lighting products and washing machine (Harrington and Damnics. 2004).

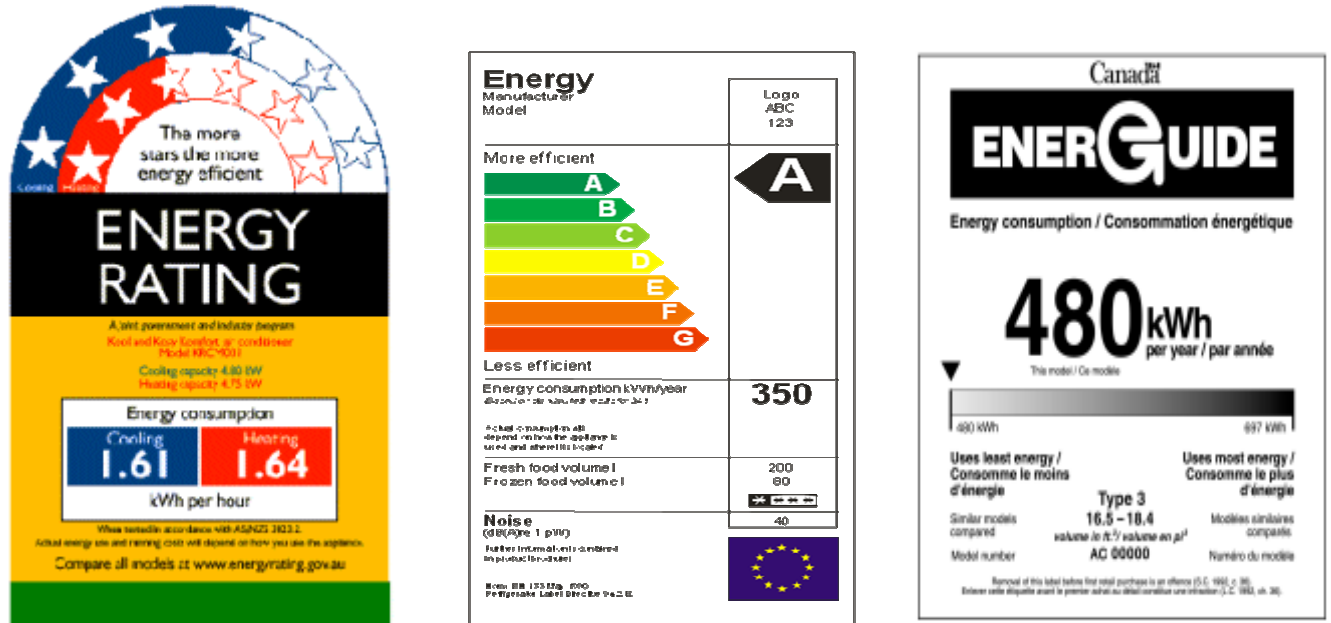
There are two types of labels - **Endorsement Labels** and **Comparative Labels**. Endorsement labels point out to consumers that products belong to the “most energy efficient” class of products or meet a predetermined standard or eligibility criteria (Harrington and Damnics, 2004). This type of label merely informs the consumer that the products meet certain required standard. Endorsement labeling can be done specifically to provide information on energy efficiency or for other purposes.

Comparative labeling allows consumers to know among products which one is more efficient. It gives the ranking of all products carrying a label. With this information, consumers are able to know which is more efficient. The most commonly used comparison labels use a scale with absolutely defined efficiency categories. This type of label allows consumers to easily assess the efficiency of a product in relation to an absolute scale, by means of a simple numerical or ranking system (Harrington and Damnics, 2004). Endorsement and comparative labels can be placed at the same time on a product. The visual designs of comparative label used in other parts of the world can be grouped into:

Dial Label: This type of label has a clock shape or gauge and the greater efficiency is linked to advancement along the gauge; the more efficient is represented by a clockwise arc. It is used in countries like Australia, Thailand and Korea.

Bar Label: This type of label uses a bar chart with a grading from best to worst. All grade bars are visible on every label with a marker next to the appropriate bar indicating the grade of the model. This label is used primarily in Europe and South America.

Linear Label: This type of label use energy for comparing instead of efficiency. It has a linear scale indicating the highest and lowest energy use of models on the market, locating the specific model within that scale (Harrington and Damnics, 2004).



Dial label (Australia) Bar Label (Europe) Linear Label (Canada)
Fig. 4.1: Different types of labeling (Harrington and Damnics, 2004; Lebot, 2009)

Minimum Energy Performance Standards (MEPS)

Minimum Energy Performance Standards (MEPS) is also referred to as "standards" or "efficiency standards" in some countries. MEPS are specified minimum energy efficiency levels products must meet before they can be legally sold in any country (Harrington and Damnics, 2004). Here, specific energy standards are set before products are allowed into a country and sold. For example a country may decide to set a standard that refrigerators consuming more than 400kwh will not be allowed into the country. MEPS are mandatory standards and are done in a manner that they balance technical possibility with economic viability and the competitive force within a particular market.

Retrofitting Homes and Public Buildings

The practice of retrofitting homes and public buildings is now practiced in many parts of the world to reduce energy consumption. Owing to the fact that many homes and public building have been build long time ago and are equipped with all kinds of inefficient appliances, it is now a common thing for owners of home and government to replace this old equipment with newer and more efficient ones. In other parts of the world, these are many ways individuals are improving the energy efficiency in home.

Lighting: with the use of incandescent bulbs, many households spend a lot of energy for lighting. The energy we spend for lighting can be reduced by over 60% if we replace them with energy saving bulbs such as compact florescent lamps (CFLs). CFLs are much more efficient than incandescent bulbs and they last six to ten times longer. However, many of our respondents complained that energy saving bulbs in the Nigerian market are not durable and the incandescent bulbs last longer than them. In some parts of the world, the government had put a ban on the use of incandescent bulbs, a good example is in Cuba, where the Cuban Government had put a ban on the use of incandescent bulbs and also developed programmes to phase out these bulbs. For outdoor lighting, the use of timing machine can help to switch off the light automatically.

Refrigeration: Modern and energy efficient refrigerators can help save energy compared to the refrigerators design 15 years ago. In many parts of the world, old and inefficient refrigerators are being replaced by energy efficient refrigerators. Refrigerators are designed for different climate, for example there are refrigerators designed for the temperate region while others are designed for the tropical region. Using a refrigerator designed for the temperate region in a tropical climate will lead to inefficient use of energy. Refrigerators should be used in the climate where they are designed to be used. In Nigeria, the use of secondhand refrigerators from Europe should be discouraged, because these refrigerators are designed for the European climate.

Cooling and Heating: In Nigeria, the appliances for heating and cooling account for a large percentage of the energy we spend in our homes and offices. It has been found that heating and cooling account for about 44% of utility bill. The energy spent on heating and cooling can be reduced if households and owners of houses invest money for the proper insulation and weathering of their houses. Just by insulating walls and loft spaces you could reduce heat loss by over 50% and prevent wasted of energy. Also, there are modern and more efficient air conditioner and heating equipment. By combining proper equipment maintenance and upgrades with insulation, weatherization and thermostat setting, energy consumption can be reduced drastically.

Landscaping

There are natural ways we can keep our homes comfortable and reduce energy bill. A well placed tree, shrub or vine in our homes can provide shade and act as windbreak. This can help to reduce the energy we spend on cooling, since the shade from these trees can keep our home cool.

Providing Incentives

Providing incentives for purchasing energy efficiency products have been used to change the behavior of consumers to promote energy efficiency. This has been operational in other parts of the world. Policy is made to place a penalty on people using inefficient products and reward those buying very efficient appliances.

Use of Renewable Energy Technologies (RETs)

The use of solar heater to provide hot water in the house can help to reduce the amount of electrical energy spent on heating water. Solar heaters have been developed and used in other parts of the world to provide hot water in residential houses.

CHAPTER FIVE

Policy Options for Nigeria

The use of good and comprehensive policy instrument will be necessary to promote energy efficiency in Nigeria. In this chapter, from the information gathered during our study, we will suggest policy options that the Nigerian government can explore to promote the efficient use of energy. The ideas presented in this chapter are not in any way exhaustive.

Policy should be made to ban the importation, manufacturing and use of incandescent bulbs in Nigeria. Such policy should encourage the gradual phase out of incandescent bulbs from the system and encourage the phase in of energy saving bulbs. Many of our respondents complain that the energy saving bulbs in the market fail within a short time after they are purchased, suggesting that there are substandard EE bulbs in the market. Agencies responsible for standardizing goods imported into the country should be adequately equipped to combat the influx of substandard goods into the Nigerian market. Most importantly is the Standard Organization of Nigeria, with the mandate to preparing standards for products and processes and for ensuring compliance with Federal Government policies on Standards Metrology and Quality Assurance of both locally manufactured and imported products and services in Nigeria.

The influx of secondhand products into the Nigerian market is a big threat to the efficient use of energy. In many instances, the secondhand products are preferred by many Nigerians mainly because of the price. Some respondents also claimed that the secondhand products are more durable than the new ones. This notion is based on the presence of substandard goods which are not durable. Many of the secondhand products are imported from the temperate region, thus they may not be designed for use in the tropical region. This can contribute significantly to the inefficient use of energy in homes and offices. Further, many of the secondhand products imported into the country may have been manufactured long ago and are rejected in the countries where they were previously used because of their inefficiency. Policy should be directed to gradually stop the importation of secondhand goods. This could be done by placing high tariff on secondhand goods and low/no tariff on new and efficient products.

Considering the relevance of energy efficiency for national development, it will be necessary for government to set up a ministry or agency that will be responsible for promoting energy efficiency. The agency will ensure that energy efficiency policy and programmes are implemented. They will also ensure that information on energy efficiency are well disseminated, and also ensure that the training and retraining of EE staff in the different establishments are periodically done.

For medium to large scale industries, it should be made mandatory for them to establish an Energy Management Unit (EMU). The Unit should be responsible for ensuring that energy is properly managed within the organization. This policy should also be applicable in public offices such as the universities and government ministries. EMU will be trained to carry out energy audit of their various institutions. Legislation should be made to make it mandatory for private companies and government own institutions and ministries to publish the report of their energy audit. Government should introduce energy tax that will be proportional to the total energy consumed by institutions. Apart from helping in taxation, the energy audit will also help the utilities to plan. Revenue from such tax can be channeled to promote the efficient use of energy in other areas.

In many public offices such as government ministries and university offices, officials do not pay for electricity individually. What operates is that the managements of these institutions pay a lump sum of money to utility companies. Individual officers are not made to account for the energy they consume. This leads to wastage as these officers abuse this privileges. That is why you find that one single government staff will have an air conditional, a refrigerator, an electric kettle, a television set, and several desktop computers in a single office. You go to the next office, you find similar scenario. Policy should be made to make government officers to account for the energy they consume. Again, instead of everybody in the department or unit buying a refrigerator, the entire department or unit can use a central refrigerator that will serve everybody.

Government should properly plan already existing cities and emerging towns in Nigeria. Our cities should be planned in a way that the industrial areas are separated from the residential areas. This will help the utilities supplying electricity to allocate energy to the different areas appropriately. During the day, it is expected that the energy consumption in the residential areas is reduced, thus more energy can then be allocated for industrial activities. Similarly during the night hours, the consumption in the residential areas will increase; while there will be decrease in the industrial areas. Then more energy can then be made available for use in the residential areas. Local, state and federal governments should develop policy in this direction.

The proliferation of water borehole in many town and cities in Nigeria is energy intensive. Just like we mentioned earlier, this is because government has failed to provide water in many parts of Nigeria. The energy spent daily to pump water from the aquifer by private individuals can be drastically reduced if government spends extra money to provide water for her citizens. Access to water is the right of every citizen in Nigeria. Policy should be directed toward providing water for Nigeria. This will help to minimize the sinking of boreholes by individuals.

Lack of trained personnel is a major factor hindering the development of energy efficiency in Nigeria. Policy should be made to make it mandatory for private companies such as banks,

hotels, industries to train their staff on energy management. The use of incentives is also another way government can promote the efficient use of energy. Public and private organizations can be given certain incentives to help them transit from inefficient use of energy to the efficient use of energy. This incentive could include government paying certain percentage of the cost of transiting.

We believe it will be necessary for government to set up a National Fund for Energy Efficiency. The sources of this fund can come from the taxes paid by companies that deal on the exploration of petroleum. Another source could be the penalty paid by companies that emit greenhouse gases and from energy taxes. Government can explore other sources for this fund, but it should be tied to things that relates to climate change. The sources can also be voluntary, that is organizations can contribute to it in the form of grants. Financial penalty should be placed on those found living their outdoor light on during the day, this money should be channeled into the fund.

CHAPTER SIX

Checklist of Some Home and Office Appliances in Nigeria

This chapter provides information on some appliances used in homes and offices in Nigeria. We will also establish the level of correlation between the price of some appliances (air conditioners) and their power. The list below is not in any way exhaustive; this is what we came across during our study. This will be further reviewed in our subsequent reports.

Table 6.1: List of some home and office appliances in Nigeria

S/N	Equipment	Manufacturer	Energy it consumes
1	Iron	Binatone	1200W
2	Iron	Philips	1000W
3	Iron	Philip	950-1100W
4	Iron	National	1000W
5	Hotplate	Apple	1200W
6	Toaster	Philips	950W
7	Fridge	Thermocool	1000W
8	Fridge	Exquisit	1200W
9	Fridge	Philips	1000W
10	Deep Freezer	Coolstar	130W
11	Deep freezer	Ignis	450W
12	CD Player	Sony	30W
13	4Loader CD Player	Victor	80W
14	3Loader CD Player	Kenwood	65W
15	3Loader CD Player	Aiwa	140W

16	Radio	Aiwa	30W
17	Radio	Crown Star	32W
18	Radio	Sharp	35W
19	Stabilizer	Qlink	1500W
20	Stabilizer	Sure link	5000W
21	Stabilizer	Volt plus	2000W
22	Hand dryer	Fenici	1200W
23	Hand dryer	Ideen welt	1200W
24	Standing fan	Fanafrik	100W
25	Standing fan	OX	220W
26	Computer (C.P U)	Dell	80W
27	Satellite decoder	Multichoice	72W
28	Satellite decoder	MYTV(Strong)	30W
29	T.V antenna	Sonik	3.5W
30	Micro wave	LG	750W

Table 6.2: Table showing some appliances with their prices

S/n	Equipment	Manufacturer	Power(watt)	Price(₦)
1	TV (21 inches)	Sharp	84	24,000
2	TV	LG	65	23,000
3	Electric kettle	Ressell Hobb	2000	3,000
4	Iron	Phillip	1100	2,500

5	Iron	Binatone	1200	2,000
6	Rice cooker	Philips	700	10,000
7	Hair drier	Ideen welt	1200	1,500
10	Blender	Ken wood	350	4,500
11	Blender	Surex	350	2,500
12	Barbing machine	Chaoba	10	1,300
13	Barbing machine	Binatone	13	2,500
14	Fridge	Nexus	1030	40,000
15	Dry iron	Sonik	1000	1,700
16	Dry iron	Akira	1000	1,400
17	Steam iron	Crown star	2200	2,200
18	Dry iron	Stolle	1200	2,000
19	TV	LG	85	30,000
20	DVD player	LG	1000	65,000
21	DVD play	Sony	10	15,000
22	Micro wave	Panasonic	2800	12,000
23	CFL	Silvana	28	300
24	FAN	ORL max	70	2,700
25	fan	ORL Deluxe	70	3,500
26	FAN	ORL Sarta	70	2,800
27	DVD	LG	70	4,500
28	DVD	Sony	25	4,000
29	DVD	Samsung	15	4,500
30	DVD	Sharp	15	5,000

31	Home theater DVD	LG	50	18,000
32	Iron	QLink	1200	2,500
33	Electric kettle	Binatone	2000	3,500
34	blender	Mammonlex	240	3,000
35	Standing fan	Fanafrik	100	2,000
36	TV	Samsung	110	15,000
37	Video Player(cassette)	Sharp	13	2,000
38	Compact hair Handdryer	Fernici	1200	1,500
39	Blender	Binatone	13	2,500
40	Split AC	LG	1500	84,000
41	Split AC	LG	1120	70,000
42	Window AC	LG	1500	56,000
43	Window AC	LG	1120	52,000
44	Window AC	LG	750	37,000
45	Split AC	Panasonic	1500	82,000
46	Window AC	Panasonic	1500	52,000
47	Split AC	Panasonic	1120	77,000
48	Window AC	Panasonic	750	35,000
49	Window AC	Samsung	750	35,000
50	Window AC	„	1120	49,000
51	AC	„	1500	55,000
52	Split AC	„	1500	83,000
53	AC	„	1120	70,000

54	AC	„	750	49,000
55	Incandescent bulbs	Philip	40	30
56	„	Philip	60	50
57	„	Philip	100	60
58	„	„	200	100
59	CFL	Visicom	26	200

The level of correlation between the power and cost of air conditioners was found to be significant at 0.01 confident limits. In other words, there is correlation between the two variables (power and cost). As the power increases, the price also increases. This suggests that more efficient appliances do not necessarily mean increase in price.

Table: 6.3: Correlation analysis between power and cost (Air conditioners)

		Power	Cost
Power	Pearson Correlation	1	.675(**)
	Sig. (2-tailed)		.006
	N	15	15
Cost	Pearson Correlation	.675(**)	1
	Sig. (2-tailed)	.006	
	N	15	15

Correlation is significant at the 0.01 level (2-tailed).

CHAPTER SEVEN

Renewable Energy Potential in Nigeria

Renewable Energy

Renewable energies include wind, ocean wave and tides, solar, biomass, rivers, geothermal (heat of the earth), etc. They are called 'renewable' because they are regularly replenished by natural processes and are therefore in endless supply. They also can operate without polluting the environment. Technologies that have been developed to harness these energies are called renewable energy technologies (RETs) or sometime also called "clean technologies" or "green energy". Because renewable energies are constantly being replenished from natural sources, they have security of supply, unlike fossil fuels, which are negotiated on the international market and subject to international competition, sometimes may even resulting in wars and shortages. They have important advantages as follows:

- Their rate of use does not affect their availability in future, thus they are inexhaustible.
- The resources are generally well distributed all over the world, even though wide spatial and temporal variations occur. Thus all regions of the world have reasonable access to one or more forms of renewable energy supply.
- They are clean and pollution-free, and therefore are sustainable natural form of energy.
- They can be cheaply and continuously harvested and therefore sustainable source of energy.

Renewable energy can be set up in small units and is therefore suitable for community management and ownership. In this way, value from renewable energy projects can be kept in the community. In Nigeria, this has particular relevance since the electricity grid does not extend to many rural areas and in some cases it is prohibitively expensive to extend the grid to remote areas. This presents a unique opportunity to construct power plants closer to where they are actually needed. In this way, much needed income, skill transfer and manufacturing opportunities for small businesses would be injected into rural communities.

RETs have the potential to produce more jobs than fossil fuel or nuclear industries. When RETs are properly integrated into national development plans and implemented, they can substantially reduce greenhouse gas emission and simultaneously increase employment. Moreover, it can also enhance energy security by reducing reliance on oil and promote energy sovereignty. With the right approach, the interests of the economy and the environment can come together when RE is properly integrated into development plans.

Wind Energy

The energy contained in the force of the winds blowing across the earth's surface can be harnessed. Such energy can be converted into mechanical energy for performing various works such as generating electricity, pumping water, grinding grain, etc. Modern wind

turbines are being used to generate electricity in countries such as Germany, Denmark, India, China, and the United States to supplement more traditional sources of electric power. Design improvements such as more efficient rotor blades combined with an increase in the numbers of wind turbines installed, have helped increase the world's wind energy generating capacity by nearly 150 percent since 1990 (Microsoft 1999).

With wind energy available in Nigeria vary from the extreme south to the extreme north. The wind speed in the south ranges from 1.4 to 3.0 m/s. The wind speed is higher in the northern Nigeria, from 4.0 to 5.12 m/s (ECN 2008). Nigeria possess enormous potential to develop and utilize energy from the wind for electricity generation. The coastal regions of the south and the northern part of the country are possible suitable sites for wind energy exploitation. Wind turbines are suitable for power generation in remote places where energy is needed but costly to connect to a central source. They are particularly suitable for development of energy in rural communities in developing countries.

Solar Energy

Solar energy can be collected using artificial devices called solar collectors. The energy collected can be used either in a thermal process or a photoelectric (photovoltaic) process. When used in a thermal process, solar energy is used to heat a gas or liquid. In the photovoltaic process, solar energy is converted directly to electrical energy without intermediate mechanical devices. Nigeria is blessed with enormous solar radiation that can be harnessed; solar radiation intensity varies from 7.0kwh/m² at the extreme north to 3.5kwh/m² in the extreme south. This is figures are sufficient for thermal and photovoltaic application (ECN, 2008).

Geothermal Energy

Geothermal energy is the energy gotten from the heat that originates from the earth crust. Report shows that in 2004, over 9,000 mega watts of electricity were produced from 250 geothermal power plants in 22 countries around the world. These plants produced power for well over 60 million people living mostly in the developing countries. Some African countries have already started exploring the energy potentials offered by this renewable source of energy. Nigeria has some potential to harness energy from this source of renewable energy. There are two major geothermal energy resource sites presently known in Nigeria. They are Ikogosi Warm Spring in Ondo State and the Wikki Warm Spring in Bauchi State. Outside these two major sites, other sites have been identified in the Lagos sub-basin, the Okitiputa Ridge, Auchi-Agbede within the Benin Flank/Hinge Line and the Abakaliki Anticlinorium (ECN-UNDP, 2005).

The advantage of this source of energy is that it has a very high rate of security. More also, it is available for 24 hours a day all the year round. The capacity of geothermal plants can range from 20MW to 60MW. It is also not harmful to the environment: that is it does not contribute to the problem of climate change (ECN-UNDP, 2005).

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