ELECTRIC-POWER ENERGY SITUATION AND THE NEED FOR IMPLEMENTING ENERGY EFFICIENCY MEASURES IN NIGERIA: A REVIEW.

Obuka, Nnaemeka S.P[1*]., Utazi, Divine N[2]., Onyechi, Pius C[3]., and Agbo, Cornelius O[2].

1 Department of Mechanical-Production Engineering, Enugu State University of Science and Technology, Enugu, Nigeria.

2 Department of Mechanical Engineering, University of Nigeria, Nsukka, Nigeria.

3 Department of Industrial-Production Engineering, Nnamdi Azikiwe University, Awka, Nigeria.

Abstract

This review takes a look at the present epileptic situation of electric energy production and supply in Nigeria and justifiably highlights the importance of energy efficiency measures to be implemented at all stages of the electricity (energy) sector from generation (upstream) down to the end-use point (downstream). The growth, prosperity and national security of any country are critically dependent upon the adequacy of its electricity supply industry. Nigeria as a developing country is in great need to improve her electric energy generation, transmission, and distribution outlook. With her Vision 20:2020 target of 40GW, it is imperative that the efficient use of this energy especially the already available capacity should be made a priority both in policy and implementation. Construction and addition of new electric-power plants to the national grid is a welcomed development, but the efficient use of the energy so generated will reduce the need for and the cost of constructing more power plants.

Keywords: Electricity Sector, Electric-Energy, Power, Power Plant, Energy Efficiency, Vision 2020, Nigeria.

***Corresponding Author:** (Obuka Nnaemeka S.P.)

1. INTRODUCTION

Presently, over 20% of the global population lack access to electricity and 40% rely on the traditional use of biomass for cooking [1]. The United Nations estimates that if nothing is done by 2030, 900 million people will not have access to electricity, 3 billion people will still cook with traditional fuels, and 30 million people will have died due to smoke-related diseases and many hundreds of millions would be confined to poverty due to lack of energy access [2]. Nigeria is the world's most populous black nation with the population of estimated 160 million, there is no doubt that greater percentage of Nigeria population is among this over 20% of the global population that lack access to electricity. Electricity is fundamental and inevitable to our daily living as it lightens our environment, powers our homes, schools, hospitals, offices, businesses, and promotes industrialization. Stable energy supply is of vital importance for the wealth of a country. Most of the electricity is provided by generators, since the central electricity grid in Nigeria is very unstable with power failure being more rule than exception.

Only 40% of the Nigerian population has access to the central electricity utility and this is mainly in the urban areas [3]. Buildings account for about 40% of electricity consumption [4] with the consumption disaggregated into 48% end-use of appliances, 40% cooling and 12% lighting consuming of total electricity respectively [5],[6]. Batagarawa et al [5] in their study investigating the consumption pattern of commercial mix-mode buildings in Nigeria show that as high as 75% of the time, electricity is supplied through back-up power. Another study on energy efficiency in Nigerian buildings [7] has shown that 99% of the respondents who took

part in its survey have interrupted electricity supply every day. Due to the deficit of electricity supply in Nigeria, a large portion of industry, businesses, households depends on diesel and petrol generators as primary back-up source of electricity. Where available, a large part of the energy generated is wasted due to the wasteful behavior and technologies being used, the need to manage the available one cannot be overemphasized. 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 [8].

1.1 Brief History of Nigeria Electric Power Sector

The history of electricity in Nigeria dates back to 1896 when two generating sets were installed to produce electricity in Lagos, fifteen years after its introduction in England [9]. In the 1950s, the demand for electricity was below its supply and the industry was able to meet the country's need at that period. However, the demand for electricity gradually increased and later outstripped supply as industrialization set in [10]. Though electricity production has existed for more than a century in Nigeria, yet its development has been very slow. Electricity Corporation of Nigeria (ECN) was established in 1950 to be responsible for electricity supply and development in Nigeria. Niger Dams Authority (NDA) was also established by an act of parliament in 1962.This Authority was responsible for the construction and maintenance of dams and other works on the River Niger and other hydro generating plants. Electricity produced by the NDA was sold to ECN for distribution and sales at utility voltages [11]. In 1972, Nigerian Electric Power Authority (NEPA) was established by the Government by merging ECN and NDA.

NEPA has since operated as a government-controlled monopoly responsible for power generation, transmission, and generation. Subsequent to the introduction of the Electric Power Sector Reform Act in 2005, NEPA transformed into the Power Holding Company of Nigeria (PHCN) which was later unbundled into 18 companies, including 6 generators, 11 distributors and one transmission company. These companies are responsible to carry out the functions relating to the generation, transmission, trading, distribution and bulk supply as well as resale of electricity [12]. The reform has been able to introduce a new set of players such as the Independent Power Producers (IPPs) and Nigeria Electricity Liability Management Company (NELMCO). The power sector is now regulated by the National Electricity Regulatory Commission (NERC) under the Federal Ministry of Power. On November 2013, the Federal Government formally handed over the assets unbundled from the Power Holdings Company of Nigeria (PHCN) to private organizations that bought them, with a pledge that they would take over the companies without any liabilities. The ensuing liabilities of PHCN had been pooled together and would be managed by Nigerian Electricity Liability Management Company (NELMCO).

2. LITERATURE OF WORKS

According to [13], electric power as a major component in the requirements for effective industrialization and development is grossly inadequate in Nigeria. Throughout the world, electricity is the most widely used and desirable form of energy. As a country's population grows and its economy expands, its demand for electrical energy multiplies. Nigeria for many years has been facing extreme electricity shortage, this deficiency is multifaceted, with causes that are financial, structural, and socio-political and none is exclusively mutual [14]. Idigbe and Onohhaebi [15] put it that presently; the power industry in Nigeria is beset by major difficulties in the core areas of operation: generation, transmission, distribution and marketing. The performance of the power sector in Nigeria has remained poor, in comparison with other developing countries, inspite of Nigeria's huge resource endowment in energy and enormous investment in the provision of energy infrastructure. In terms of performance and efficiency, the Nigerian electric power sector has been rated by the UNDP/World Bank Report [16] as having one of the highest rate of losses at 33%, the lowest generating capacity factor of 20%, the lowest revenue at 1.56c/kWh, the lowest rate of return at -8% and the longest average account receivable period of 15months. These are when compared with a group of 20 low income and middle income nations in Africa.

Table 1, provides an interesting comparison of selected power indicators of technical and finanacial efficiencies between Nigeria and the average for a group of African countries. Nigeria efficiency performance on all counts is much worse than for a set of middle income African nations [17].

Table 1. Selected Power Sector Indicators of Performance for Nigeria and Africa (2004/05) [17]

Indicators	Nigeria	Average Africa	
		Low Income Countries	Middle Income Countries
1. Technical Efficiency			
Ingeneration capacity (MW)	598	918	13651
MW per million population	42	32	404
MW in operation condition as % of installed capacity	61	84	97
Per capita (kWh/cap)	173	141	1912
Self-generated as % of electricity generated	42	10	0.7
2. Effective Residential Tariff (cents/kWh)	4.1	12	32
3. Number of Unplanned Outages per year	1059	3089	39
4. Efficiency			
Labour efficiency (ann. Labour costs as % of ops. expense)	48	29	11
5. Efficiency Ratio (%)			
T and D losses	30	25	13
Cost recovery (based on effective tariff)	36	64	56
Implicit collection (based on effective tariff)	52	83	95
6. Total Hidden Costs of Inefficiencies			
As % of GDP	1.4	2.0	0.6
As % of utility revenue	229	125	13

This shows that Nigeria as a country regarded as the giant of Africa is lagging behind in the electric power sector even when compared with lesser African nations. Therefore, beside the increase in generating electricity, implementing energy efficiency measures is imperative and can go a long way to help in improve the energy situation of this great nation. Energy efficiency is a concept expressed by a set of measures or the effects of these measures whose objective is a reduction of energy consumption such that consumer satisfaction is maintained. Energy efficiency is not simply confined to the management of demand, but can also be applied to production, transportation and distribution of energy [18]. A common indicator of energy efficiency is the index of energy intensity which measures the quality of energy required to generate one dollar unit of aggregate output [17]. The lower the value of energy intensity, the more efficient and economy.

However, energy efficiency also means improvement in practice and products that reduce the energy necessary to provide services like lighting, cooling, heating, manufacturing, cooking, transport, entertainment, etc. Energy efficiency products essentially help to do more work with less energy [19]. Energy efficiency is also defined as essentially using less energy to provide the same service [20]. In this sense, energy efficiency can also be thought of as a supply resource – often considered an important, cost effective near to midterm supply option. Investment in energy efficiency can provide additional economic value by preserving the resource base (especially combined with pollution prevention technologies) mitigating environmental problems.

2.1 Present Electricity Situation

The electricity sector in Nigeria is presently characterized by chronic power shortages and poor power quality supply. With an increased population coupled with diversification of economic activities, energy demand is rising but yet, electricity supply is relatively stagnant. It is therefore obvious that electricity demand is way above its supply. The inefficiency as well as inadequate facilities to boost electricity supply has also been a major cause of the increasing gap between demand and supply of electricity [21].
Currently, 15.3 million households lack access to grid electricity; and for those connected to the national grid, supply is erratic at best [22]. Per capita electricity consumption has been less than 150KWh per annum [23]. Rural areas suffer the most electricity deprivation. Energy deprivation in Nigeria goes beyond lack of access to electricity. An estimated 72% of Nigerians depend solely on wood as a source of fuel for cooking [24]. Contrary to the expectations of the National Energy Policy of 2003, deepening poverty has forced a reversal in the transition to modern and efficient energy forms. Today, more Nigerians are climbing down the energy ladder – moving from electricity, gas and kerosene to fuel wood and other traditional biomass energy forms [25].

The Total Installed Capacity of the currently generating plants is 7, 914.4 MW (Table 2). Seven of the fourteen generation stations are over 20 years old and the average daily power generation is far below the installed

capacity. As a result, the nation experiences massive load shedding. Through the planned generation capacity projects for a brighter future (Table 3); the current status of power generation in Nigeria presents the following challenges:

(i). Inadequate generation availability (ii). Inadequate and delayed maintenance of facilities (iii). Insufficient funding of power stations (iv). Obsolete equipment, tools, safety facilities and operational vehicles
(v). Inadequate and obsolete communication equipment
(vi). Lack of exploration to tap all sources of energy form the available resources, and
(vii). Low staff morale [26].

TABLE 2: Existing Power Generation Capacity in Nigeria [27].

Plant	Age (Years)	No of Units	Installed Capacity (MW)	Current No of Units Available	Capacity Available (MW)	Operational Capability (MW)
Egbim	23	6	1320	4	880	600
Egbim A ES	7	9	270	9	270	220
Sample	26-30	10	1020	1	90	65
Okpai	3	3	480	3	480	400
Afam	26	20	702	3	350	300
Delta	18	18	840	12	540	330
Omoku	3	6	150	4	100	70
Ajaokota	N/A	2	110	2	100	80
Geregu	2	3	414	3	414	414
Omotosho	1	8	335	2	80	75
Olounsogo	1	8	335	2	80	35
Kainji	38-40	8	760	6	440	400
Jebba	25	6	578.4	4	385.6	300
Shiroro	22	4	600	4	600	300
Total		111	7914.4	59	4809.6	3589

TABLE 3: Planned Total Present and Future Electricity Generation Infrastructure in Nigeria [26].

S/N	POWER STATION	TYPE	STATION	CAPACITY (MW)	STATUS
1	Egbin	Thermal	Lagos	1320	Existing
2	Afam	Thermal	Rivers	969	Existing
3	Sapele	Thermal	Delta	1020	Existing
4	Ijora	Thermal	Lagos	40	Existing
5	Kanji	Hydro	Niger	760	Existing
6	Jebba	Hydro	Niger	578.40	Existing
7	Shiroro	Hydro	Niger	600	Existing
8	Delta	Thermal	Delta	912	Existing
9	Orji	Coal	Rivers	20	Existing
10	Geregu	Thermal	Kogi	414	Ongoing
11	Omotosho	Thermal	Ondo	335	Ongoing

12	Papalanto	Thermal	Ogun	335	Ongoing
13	Alaoji	Thermal	Abia	504	Ongoing
14	Omoku	Thermal	Rivers	230	New IPP
15	Rain/Ube	Thermal	Bayelsa	225	New IPP
16	Sapele	Thermal	Delta	451	New IPP
17	Eyaen	Thermal	Edo	451	New IPP
18	Egbema	Thermal	Imo	338	New IPP
19	Caliber	Thermal	Cross River	561	New IPP
20	Mambilla	Hydro	Taraba	2600	New
21	Zungeru	Hydro	Niger	950	New
22	AES	Thermal	Lagos	300	Commissioned IPP
23	AGIP Okpai	Thermal	Delta	480	Commissioned IPP
24	Omoku	Thermal	Rivers	150	Approved IPP
25	Obajana	Thermal	Kogi	350	Approved IPP
26	Ibom Power	Thermal	Akwa Ibom	188	Approved IPP
27	Ethiope Energy Ltd			2800	Approved Licenses IPP
28	Farm Electric Supply Ltd			150	Approved Licenses IPP
29	ICS Power			624	Approved Licenses IPP
30	Supertek Ltd			624.00	Approved Licenses IPP
31	Mabon Ltd			39.00	Approved Licenses IPP
32	Geometric Ltd			140.00	Approved Licenses IPP
33	Aba Power Ltd			0.00	Licensed Distributor
34	Westcom Tech & Energy Service Ltd			1000.00	License Granted IPP
35	Lotus & Bresson Nig Ltd			60.00	License Granted IPP
36	Anita Energy Ltd			136.00	License Granted IPP
37	First Independent Power Co Ltd			95.00	License Granted IPP
38	First Independent Power Co Ltd			150.00	License Granted IPP

39	Hudson Power Station Ltd			200.00	License Granted IPP
40	Ibafo Power Station Ltd			640.00	License Granted IPP
41	Shell Distribution Coy Ltd			100.00	License Granted IPP
42	Agbara Shoeline Power Co Ltd			1800.00	License Granted IPP
43	Index Thermal Power Ltd			1800.00	License Granted IPP
	TOTAL			**24, 106.00**	

Commercial electricity generation in Nigeria currently comes from 7 power stations and various independent Power Projects around the country. Thus, the current nation's available electricity generating capacity is about 3,920MW with per capita power capacity of 28.57 Watts and this is grossly inadequate even for domestic consumption [28]. For Nigeria to meet up its energy needs, it requires per capital power capacity of 1000 Watts or power generating/handling capacity of 140,000 MW as against the current capacity of 3,920 MW. Consequently, availability of power in the country varied from about 27% to 60% of installed capacity, while transmission and distribution losses accounted for about 28% of the electricity generated in the country [29]. The target is to achieve 40,000MW by 2020 under the road map for the power sector. In the medium term, up to December 2013, 14,000MW is expected to be generated from the Power Holding Company of Nigeria (4,500MW), National Integrated Power Plant (4775MW) and new IPPs (3300MW) [30].

3. MATERIALS APPLICABLE AND METHOD

3.1. Demographics and Power Consumption

The rule of thumb for any developed industrial nation is that at least 1 gigawatts (i.e. 1,000megawatts) of electricity generation and consumption is required for every 1million head of population. This rule provides a useful indicator as to the scale of the investments that will need to be made in the Nigerian Electricity Supply Industry over the coming decades [31]. Nigeria is hereby compared with some countries of the world based on this rule of thumb; this comparison is graphically shown in Fig 1.

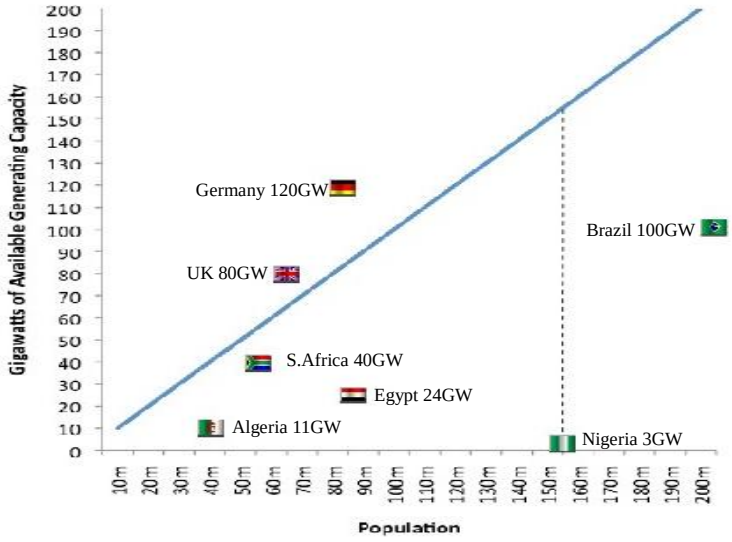

Fig. 1: Generating capacity and country population

The following deductions can be made from the figure above: (1). Nigeria's per capita electricity consumption is amongst the lowest in the world and far lower than other African countries. (2). Nigeria's per capita electricity

consumption is just 7% of Brazil's and just 3% of South Africa's. (3). Brazil has 100,000MW of grid-based generating capacity for a population of 201 million people. (4). South Africa has 40,000MW of grid-based generating capacity for a population of 50million people. (5). As at August 2010, the peak generation supplied by Nigeria's PHCN was just 3,804MW for a population of over 150million people.

3.2. Nigeria Vision 20:2020 Power Generation Aspiration

An analysis of the power generation capacity required to support the vision 2020 economic vision, carried out by the Energy National Technical Working Group (NTWG), shows that by 2020 Nigeria will need to generate electricity in the range of between 25,000MW to 40,000MW. This is based on the assumption that the country will take a less energy intensive growth path (energy intensity of less than 0.4) with lower electricity consumption, KWh per unit of GDP, unlike China which has an energy intensity of 0.91 [32].

In 2005, the Federal Government of Nigeria launched an ambitious capital investment programme under the title of the National Integrated Power Project (NIPP). The NIPP projects comprise both gas-fired power plants and transmission lines. When completed, the NIPP projects which is an adopted child of Niger Delta Power Holding Company (NDPHC) should add nearly 5,000MW to the country's generating capacity the December, 2013. It is worthy to note that 90% of this project has been completed and awaiting commissioning as at December, 2013. However, the NIPP's contribution is drop in the ocean compared to the investments that will be required for the country to meet the generating target of 40,000MW which it has set itself for 2020. Moreover, if this target of 40,000MW were to be met, Nigeria's power capacity per head of population in 2020 would still be less than a quarter of what South Africa currently enjoys [31].

Nevertheless, to reach this relatively modest ambition of 40,000MW, will require investments in power generation capacity alone of at least USD$3.5billion per annum for the next 10 years. Likewise, large investments will also have to be made in the other parts of supply chain (i.e. the fuel-to-power infrastructure, the power transmission and distribution networks), bringing a total USD$10billion per annum spending to achieve the vision 20:2020 aspiration. Figs. 2 and 3 show the generating capacity for short term and medium term plan respectively up to 2013.

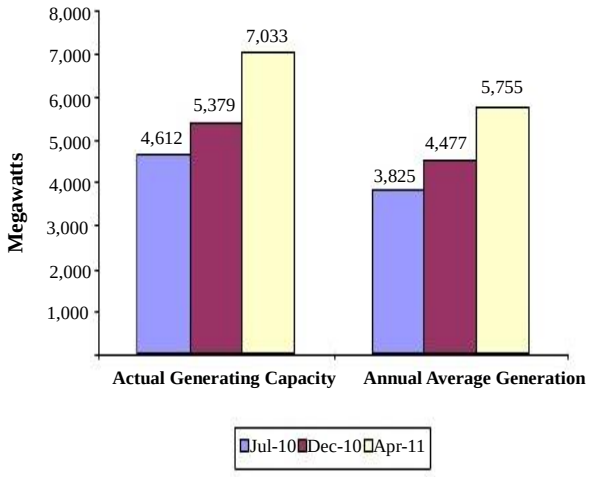

Fig. 2: Generating capacity of grid-connected power plants between July 2010 and April 2011

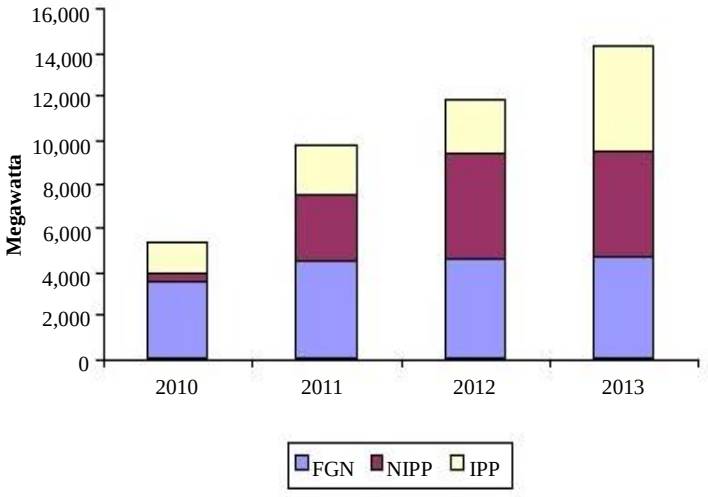

Fig. 3: Projected generating capacity of grid-connected power plants between Dec 2010 and Dec 2011

In order to achieve this aspiration, the Federal Government of Nigeria should take some proactive steps through proper legislation and awareness creation to efficiently use the available energy so that more Nigerians can have access to power supply, even as we harness the alternative energy resources like Coal, Biomass, Wind, Solar and Nuclear.

3.3. Efficient Use of Energy

In a developing country like Nigeria where electricity is in short supply, efficient use of energy will enhance consumption of electricity. This would include education of the public on energy conservation and efficiency. It also involves a review and upgrade of energy efficient standards. By this we mean that buildings and appliances used in the country should have been of high standards such that it consumes the lowest quantity of energy possible. 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 [8]. The use of incandescent bulbs for lighting is energy intensive. Only about 5% of total energy used by an incandescent bulb is converted to light energy, the remaining 95% is converted to heat energy [33].

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 [8]. In Nigeria, the use of the energy saving bulbs is further promoted, as one of the ways of solving the country's energy deficit, as the electricity consumed by the usual 60walts incandescent bulb is enough to light up at least four energy saving bulbs, of the same illumination. This is significant, considering that most of the electricity consumed in Nigerian households is for illumination [34].

3.3.1. Factors against Energy Efficiency Development in Nigeria

There numerous factors which have hindered the development of energy efficiency in Nigeria. In view of their low abatement cost, energy efficiency measures remain the cheapest, cleanest and fastest means for adoption when compared to other energy options [35]. While government is investing huge resources to build more power stations to meet up with energy demand, more energy could be saved and made available to many people who do not have access to it. These multitudes of factor are but not limited to [36]; (i) Policy factor (ii) Legal and regulatory factor (iii) Information factor (iv) Technical factor (v) Research and development factor (vi) Cost factor (vii) Income factor (viii) Institutional factor (ix) Market factor (x) Government factor (xi) Funding factor (xii) Behavioural factor (xii) Technological factor (xiii) Enforcement factor (xiv) Competitive factor etc.

3.3.2. Energy Wastage through Human Behaviours in Nigeria

Energy efficiency does not mean that people should not use energy, but they should use energy in a manner that will minimize the amount of energy needed to provide services. This is possible if they improve in practices and products that we use. If one uses energy efficient appliances, it will help to reduce the energy necessary to provide services like lighting, cooling, heating, manufacturing, cooking, transport, entertainment etc. In Nigeria, a lot of energy is wasted because households, public and private offices, and industries use more energy than is actually necessary to fulfill their needs. Some of the unwholesome practices that lead to energy wastage are as thus; (a) Use of old and inefficient equipments (b) Popular use of incandescent light bulb (c) Day light-on (d) Encouragement of private owned boreholes (e) Leaving appliances on stand-by mode (f) Improper town planning (g) Simultaneous use of multiple appliances in Public buildings (h) Use of secondhand appliances (i) Inefficient heating equipments (j) Leaving equipments on when not in use; etc. [37].

3.4. Best Practices and Technologies for Promoting Energy Efficiency

End-use efficiency is referred to as technologies, appliances or practices that improve the efficient use of energy at the level of the final user. On the side of utility companies, providing electricity, they can also device ways and technologies to promote the efficient use of energy. There are practices which are considered best; which have been adopted in other parts of the world to promote energy efficiency [38], they include; (1) Standards and Labels (2) Minimum energy performance standards (MEPS) (3) Retrofitting homes (4) Landscaping.

3.4.1 Standards and Labels

Energy labels are attached to electrical appliances to show the accurate energy consumption information on the product. Standards and labels are commonly used in many countries of the world to promote the efficient use of energy. Energy label provides information on the amount of energy an appliance consumes, thus helps the consumer to know the level of efficiency of the equipment. Commonly labeled appliances include; freezers, refrigerators, air conditioners, cookers, boilers, lighting products, washing machines, etc. [39]. Two main categories of labels widely used are; Endorsement labels which point out to consumers that products meets a predetermined standard or eligibility criteria; and Comparative labels which allow consumers to know among

products which one is more efficient.

3.4.2 Minimum Energy Performance Standards (MEPS)

Minimum energy performance standards are specified minimum energy efficiency levels products must meet before they can be legally sold in any 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.

3.4.3 Retrofitting Homes and Public buildings

Retrofitting homes and public buildings has become necessary in order to replace old inefficient equipments with new efficient ones. This is done at homes and offices by encouraging the following practices and technologies; **Lighting:** Many households and offices spend a lot of energy more than necessary for lighting when using incandescent lighting. The spent here could be reduced by about 60% if they were replaced with energy serving bulbs such as Compact Florescent Lamps (CFLs) and Light Emitting Diodes (LEDs). CFLs and LEDs are much more efficient than incandescent bulbs and they last six to ten times longer (Table 4). For outdoor lighting, the use of timing machine can help to switch off the light automatically at a specific time.

Table 4: Available Lamp Technologies in the Domestic Sector

Technology	Typical Product Life (hrs)	Luminous Efficiency (lm/W)
Incandescent	Up to 1000	5-15
Halogen	Up to 5000	10-20
Compact (and linear) Fluorescent	6000-15000	30-70
Light Emitting Diode (LED)	5000-50000	40-120

Refrigerating: The use of recent technologies in refrigeration can help save energy compared to the refrigerators designed 15years ago. However, refrigerators are designed for different climatic conditions; there are those designed for the temperate regions and those for the tropics. Any swap in use for these refrigerators will certainly lead to inefficient use of energy. **Cooling and Heating Systems:** It has been found that heating and cooling account for about 44% of utility bills at homes and offices. The energy spent on heating and cooling can be reduced if households and owners of houses invest money for proper insulation and weathering of their houses. By insulating walls and loft spaces heat loss could be reduced by over 50% and prevent waste of energy. There are also, modern and efficient air conditioners and heating equipments, and by combining proper equipment maintenance and upgrades with insulation, weatherization and thermostat setting, energy consumption can be reduced drastically. **Landscaping:** Landscaping is a natural and beautiful way to keep homes comfortable and reduce energy consumption by up to 20%. Beside adding aesthetic value and environmental quality to homes; trees, shrubs or vines can help deliver effective shade and act as windbreaks. For instance, in a warm climate, it is advisable to use windows with special coating that will help to reduce heat gain. Replacing single paned windows with double-paned windows can help to reduce heat gain and reduce the energy spent on cooling. **Renewable Energy Technologies:** The use of renewable energy technologies can help to reduce the use of electricity. For example, households and hotels can use solar heaters to provide hot water thus this will help to reduce the amount of electrical energy spent on heating water and associated heating necessities.

4. END-USE MONITORING STUDY IN NIGERIA

One of the components of the on-going United Nations Development Programme (UNDP) and Global Environment Facility (GEF) Energy Efficiency Project in conjunction with Energy Commission of Nigeria and Federal Ministry of Environment is to set minimum energy performance standards (MEPS) for lighting, air-conditioners and refrigerators in Nigeria [40]. In setting the MEPS, UNDP/GEF project team embarked upon end-use metering in six geo-political zones in Nigeria. The results of the study are really very important in understanding the current level of efficiency of the targeted equipment in Nigeria.

Fig. 4 shows that the highest energy consuming air conditioner was recorded as 3307 kWh/annum while the lowest was approximately 92 kWh/annum and an average of 1387 kWh/annum. The average annual consumption for Fridge-Freezer was recorded as 698 kWh/annum; the highest consumption was recorded as 1230 kWh/annum while the lowest was 427 kWh/annum (Fig. 5).

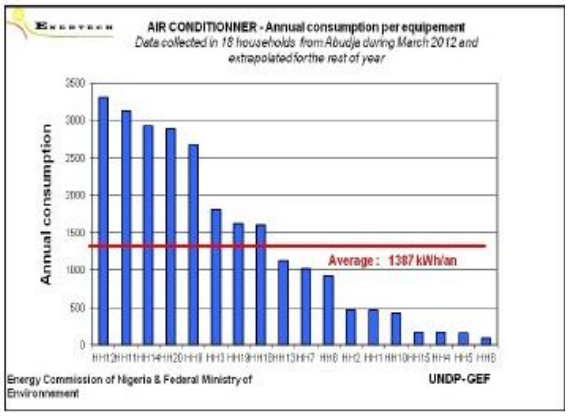

Fig. 4: Annual consumption of air conditioner in Nigeria

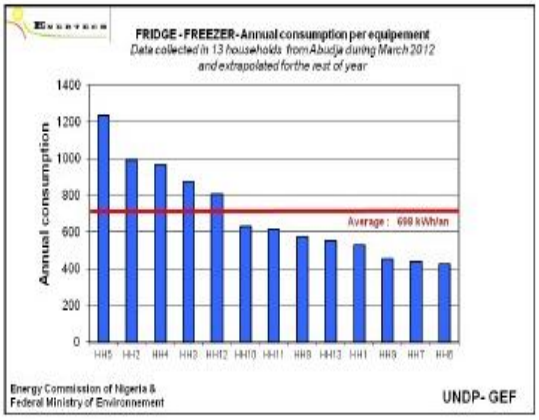

Fig. 5: Annual consumption of fridge-freezer in Nigeria

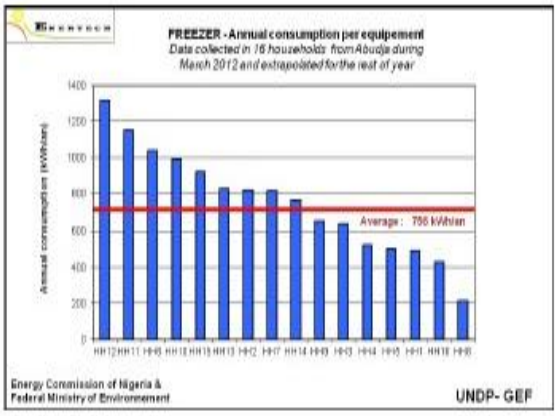

Fig. 6: Annual consumption of freezers in Nigeria

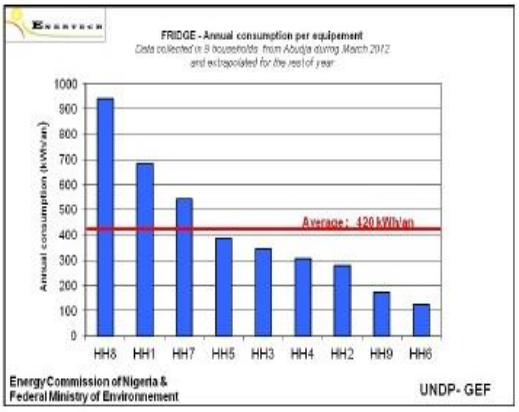

Fig. 7: Annual consumption of fridges in Nigeria

The average annual consumption for Freezers (popularly called Deep Freezers) was 756 kWh/annum, highest consumption was approximately 1318 kWh/annum, while the lowest was 212.50 kWh/annum (Fig. 6). Finally, Fig. 7 shows that the highest energy consuming Fridges was recorded as 941 kWh/annum, the lowest was 125 kWh/annum, and the average annual consumption was 420 kWh/annum. When compared with the results of similar study in Europe, the average energy consumption of these appliances are highest in Nigeria, with those of Europe decreasing with time (Table 5). This may be as a result of several energy efficiency measures such as standards and label which have been introduced in many European countries.

Table 5: Comparison of Average Annual Consumption for Nigeria and European Countries [40]

	Annual Consumption per Equipment (kWh/annum)		
	Fridge	Fridge-Freezer	Freezer
France 2007	253	460	556
Sweden 2007	225	469	556
England 2011	162	427	344.5
Nigeria 2012	**420**	**698**	**756**

5. CONCLUSION

Energy is the vital backbone of any economy, research and development backed up by energy efficiency will be beneficial to the nation. Energy consumed in Nigeria can be drastically reduced if Nigerians should take some proactive steps through proper legislation and awareness creation to efficiently use the available energy so that more Nigerians can have access to power supply. For instance, if a particular household that is using 15 incandescent bulbs of 100W decides to replace them with energy saving bulbs of 20W, instead of spending 1500W/h (15 x 100W) for lighting, they will be spending 300 watts per hour (15 x 20W). Thus this saves 80% 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 80MW 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 2960MW of electricity. Moreover, 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. As we look forward to generating more electricity in Nigeria, effort should be made to manage effectively the presently generated electricity.

REFERENCES

[1]. World Energy Outlook (2010). International Energy Agency, Paris Cedex 15, France. www.worldenergyoutlook.org.

[2]. Boerner, B. (2012). Energy for Earning a Living. Poor People Energy Outlook: Practical Action 2012. www.practicalaction.org.

[3]. Anigbogu, N. A. (2011). Integrated Approach to Sustainable Power Development for Nigerian Cities, Archibuilt forum. Abuja, Nigerian Institute of Architects, pp.

[4]. Akinbami, J.F. K. (2010). Opportunities and challenges to electrical energy conservation and CO2 emissions reduction in Nigeria's building sector, Cities and climate change workshop. Midrand, SA, Development Bank of Southern Africa pp.

[5]. Batagarawa, A., Hamza, N. and Dudek, S. J. (2011). 12th Conference of International Building Performance Simulation Association, Sydney, 14-16 November. Sydney, Australia:International building performance simulation association.

[6]. Adelaja, A. O., Damisa, O., Oke, S. A., Ayoola, A. B., and Ayeyemitan, A. O. (2008). A survey on the energy consumption and demand in a tertiary institution, Maejo International Journal of Science and Technology, 2, (2), pp. 331-344.

[7]. Uyigue, E., Agho, M., Edevbaro, A., Godfrey, O. O., Uyigue, O. P. and Okungbowa, O. G.
(2009). Energy Efficiency Survey in Nigeria. Benin: Community Research and Development Centre, Nigeria.

[8]. Energy Efficiency Survey in Nigeria 2009, Community Research and Development Centre.

[9]. Sambo A. (2008). Matching Electricity Supply with Demand in Nigeria. International Association for Energy Economics; 4th Quarter.

[10]. Makwe J., AkinwaleY., Atoyebi M. (2012). An Economic Assessment of the Reform of Nigerian Electricity Market. Journal of Energy and Power.2:24-32.

[11]. Okoro O., Chikuni E. (2007). Power Sector Reforms in Nigeria: Opportunities and Challenges. Energy Journal.18:52-57

[12]. NTWG report. (2009). Report on the energy sector forvision 2020.National Technical Working Group Report.

[13] Chigbue, N.I. (2006). Reform of Electric Power Sector: Journey so far. A Lecture delivered at the US Africa collaboration Research Sponsored by the National Sciemce Foundation in Abuja, Nigeria.

[14] Oyedepo, S.O. (2012). Efficient Energy Utilization as a Tool for Sustainable Development in Nigeria. International Journal of Energy and Environmental Engineering, Springer Open Journal, Vol. 3, Issue 11.

[15] Idigbe, K.I., and Onohaebi, S.O. (2009). Repositioning the Power Industry in Nigeria to Guarantee Reliabilty in Operation and Services. Journal of Engineering and Applied Sciences, Vol. 4, No. 2, Pp 119-125.

[16] UNDP/World Bank Energy Sector Management Assistance Programme (ESMAP), 1993, Energy Mission Aides Memoire (2003-2007), World Bank Energy Sector Team.

[17] Eberhard, A., Foster, V., Briceno-Garmendia, C., Ouedraogo, F., Camos, D., and Scharatan, M. (2008). Underpower: The State of the Power E\Sector in Sub-Saharan Africa, Annex 2: Country Tables. Report Produced as Part of the African Infrastructure Diagnostic Study.

[18] Adenikinju, A. (2010). Efficiency of the Energy Sector and its Impact on the Competitiveness of the Nigeria Economy. International Association for Energy Economics, Pp 27-31.
[19] Schutze, E., and Worthington, R. (2002). Getting to Grips with Sustainable Energy. Publication of the Sustainable Energy and Climate Partnership.

[20] Rosen, M.A. (2008). Towards Energy Sustainability: A Quest of Global Proportion. Forum of Public Policy Online. A Journal of the Oxford Round Table.

[21]. Odularu, G. O., Okonkwo, C. (2009). Does Energy Consumption Contribute to Economic Performance? Empirical Evidence from Nigeria. Journal of Economics and International Finance Vol. 1, Issue 2, Pp. 44-58.

[22] http://www.thenationonlineng.net/2011/index.php/business/energy/3413-100m-nigerians-don't-have-access-to-electricity,-says-bpe.html

[23]. World Development Indicators, Little Green Data Book 2011

[24]. NBS-CBN-NCC Collaborative Survey, 2011

[25] Eleri, E. O., Ugwu, O., and Onuvae, P. (2012). Expanding Access to Pro-Poor Energy Services in Nigeria. International Centre for Energy, Environment and Development.

[26] Sambo, A.S., Garba, B., Zarma, I.H., and Gaji, M.M. (2008). Electricity Generation and the Present Challenges in the Nigerian Power Sector. Energy Commission of Nigeria.

[27] Obadote, D. J. (2009). Energy Crisis in Nigeria: Technical Issues and Solution. Power Sector Prayer Conference June 25-27.

[28] Ibidapo, O. O., and Ajibola, O. O. E. (2011). Towards a renewable energy development for rural Power Sufficiency. Proceedings of International Conference on Innovations in Engineering and Technology .

[29] Omokaro O. (2008). Energy Development in a Fossil Fuel Economy: The Nigerian Experience. The report of a National Dialogue to Promote Renewable Energy and Energy Efficiency in Nigeria. 55p.

[30] Worldstage National Electricity Power Confrence (2013). Theme: Moving Nigeria's Electricity Power Sector Forward Lagos- Tuesday September 24, 2013.

[31] The Presidency Federal Republic of Nigeria (2010). Roadmap for Power Sector Reform: A Customer-Driven Sector-Wide Plan to Achieve Stable Power Supply. Presidential Action Committee on Power.

[32]. Report of the Vision 2020 National Technical Working Group On Energy Sector 2009.

[33]. 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.

[34]. Ordiniaoha, B. (2012). Energy Saving Bulbs: An Emerging Threat to Public Health, from Mercury Contamination of the environment. The Nigerian Health Journal, Vol. 12, No 3, pp. 65 - 67.

[35] Tallapragada, P.V.S.N., and Adebusuyi, B.S. (2008). Nigeria's Power Sector: Opportunities and Challenges. In P.Collier, C. Pattillo, and C.C. Soludo (eds.). Economic Policy Options for a Prosperous Nigeria, New York: Palgrave Macmillan, Pp 301-327.

[36] Sambo, A.S., and Lekoetje, A.M. (2011). Promoting Energy Efficiency in Residential and Public Sector in Nigeria. UNDP/FGN: Nigeria-EE Appliances Programme, 2011-2015.

[37] CREDC (2009). Energy Efficiency Survey in Nigeria: A Guide for Developing Policy and Legislation. A publication of the Community Research and Development Centre. www.credcentre.com

[38] Uyigue, E., Yapp, J., Lebot, B., and Odele, M. (2011). Promoting Energy Efficiency in Residential and Public Sector in Nigeria. Project Training Manual GEF-UNDP Energy efficiency Programme.

[39] Harrington, L., and Damnics, M. (2004). Energy Labeling and Standards Programme throughout the World. A publication of the National Appliance and Equipment Energy Efficiency Committee, Australia. NAEEEC Report 2004/04.

[40] Energy Efficiency Trumpet (2012). The Newsletter of the UNDP-GEF-Nigeria Energy Efficiency Programme, Vol. 1, Issue 1.