Energy Efficiency and Conservation Measures: Tools for Sustainable Energy Development in Nigeria

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Abstract- **Energy is an important production factor and therefore should be managed in parallel with land, labor and capital. Energy resources and their utilization intimately relate to sustainable development. In attaining sustainable development, increasing the energy efficiencies of processes utilizing sustainable energy resources plays an important role. A sustainable energy system may be regarded as a cost-efficient, reliable, and environmentally friendly energy system that effectively utilizes local resources and networks. Energy efficiency and conservation measures have the potential to promote economic development, ensuring access to energy 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. In Nigeria, up to half of the energy currently consumed can be saved 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. This paper assesses possible ways to efficient energy utilization and conservation measures for sustainable energy development in economic sectors in Nigeria.**

Keywords- Sustainable Energy; Sustainable Development; Energy; Efficient Energy; Energy Conservation

I. INTRODUCTION

Energy, it is an essential ingredient for socio-economic development and economic growth. The objective of the energy system is to provide energy services. Energy services are the desired and useful products, processes or indeed services that result from the use of energy, such as for lighting, provision of air-conditioned indoor climate, refrigerated storage, transportation, appropriate temperatures for cooking, industrial processes such as conversion of raw materials to final products, etc. The energy chain to deliver these cited services begins with the collection or extraction of primary energy, which is then converted into energy carriers suitable for various end-uses. These energy carriers are used in energy end-use technologies to provide the desired energy services [1] .

Energy is central to sustainable development and poverty reduction efforts. It affects all aspects of development-social, economic, and environmental-including livelihoods, access to water, agricultural productivity, health, population levels, education, and gender related issues. None of the Millennium Development Goals (MDGs) can be met without major improvements in the quality and quantity of energy services in developing countries.

Energy is intrinsically linked with sustainable development at the local, national, and regional levels. At the local level, modern energy is required to improved the overall quality of life (especially, that of the poor) by enhancing productive activities and enterprise, which will result in increased incomes. At national and regional levels, adequate modern energy leads to stable economic development, promotion of trade, and enhancement of participation in global markets, besides the added benefits of better social and economic linkages [2].

The term 'Sustainable Development' has been popularised by the World Commission on Environment and Development (WCED), in its 1987 report entitled, 'Our Common Future'. The Commission defined sustainable development as 'the development that meets the needs of the present without compromising the ability of future generation to meet their own needs'[3]. Sustainable development stands on three pillars in terms of its definition for the 2002 World Summit on Sustainable Development (WSSD): social development, economic development and environmental development.

As the very basis of development, energy use is closely related to the level of productivity in the industry, commerce, agriculture and even in office activities. Energy consumption per capita is one of the indicators or benchmarks for measuring the standard of living of a people or nation. The unprecedented use of energy which began with the industrial revolution certainly brought about massive increases in productivity and changes in lifestyle. Since then energy demand has been in the increase - to produce more products, travel further and faster or to be more comfortable. Physically, energy is defined as the capacity for doing work. The capacities of energy to do work are inherent properties of energy carriers. Although energy cannot be created nor destroyed according to classical thermodynamics, its capacity for doing work can be degraded and destroyed due to system irreversibility in line with the logic of the second law of thermodynamics [4].

Some of the common energy carriers or sources are coal, petroleum, natural gas, nuclear fuels, biomass etc. All of these, the most widely used energy sources are the hydrocarbon compounds or fossil fuels which account for more than 80% of global primary energy consumption [5]. For instance, fossil energies provide about 67% of the energy needed to produce electricity - a veritable and the most terminal form of energy for transmission and distribution for industrial production processes [6]. According to the World Energy Outlook of 2006, published by EIA [7], oil in particular will continue to dominate the energy market into the foreseeable future. In contrast, renewable resources are expected to contribute about 15% at best to the total primary energy requirements by the end of 2030. The issues at stake however is that fossil energy resources upon which modern development depend have finite life span. Experts argue that if global consumption continues at its current pace, economically exploitable reserves of fossil fuels will amount to no more than 40 years for oil, around 60 years for gas and about 230 years for coal [6] .

Another source of concern in the continued use of fossil fuels in addition to its finite nature and the lack of possible replacement (at least in the short term) is in the area of the environment. Climate change and environmental externalities associated with energy consumption have become a major international issue. It has been observed that among the various sectors contributing to green house gas (GHG) emissions, industrial sector contribution was significant [8]; thus mitigating GHG emissions from the sector offers one of the best ways of confronting the climate change problem. Energy efficiency is a major key in this regard. An estimated 10-30% reduction can be achieved at little or no cost by improving efficiency of energy use in the industry.

Although Nigeria is relatively endowed with abundant fossil fuels and other renewable energy sources, the energy situation in the country is yet to be structured and managed in such a way as to ensure sustainable energy development. As a nation that has limited technological capacity but sees industrialization as constituting a crucial leverage and pre-condition for meaningful development, Nigeria should be wise enough to manage her scarce energy resources judiciously. As a matter of utmost importance, industrialists, civil servants, researchers, government officers and students inclusive in Nigeria should take advantage of opportunities in low level, low risk but high worth energy efficient measures that reduces the bottom line of any business enterprise. In so doing, a lead time will be created to pursue high-tech driven production processes that will find support at maturity in an already established energy efficient culture. Researches have shown that energy supply and end-use efficiency in the developing countries are still only two-thirds to one-half of what would be considered "best practice" in the industrialized world. According to a report by the Economic and Social Commission for Asia and the Pacific published by the United Nations, energy savings of the order of 20 to 25% can be achieved economically with existing capital stock in developing nations and another 30 to 60% may be saved if investments are made in new, more efficient capital equipment.

The increasing role of energy efficiency as a catalyst for sustainable development is realism in the industrialized countries of the world. In Nigeria the story is different at the moment as the huge benefits derivable from adoption of energy efficiency and conservation measures by various economic sectors remain largely untapped due largely to lack of awareness of the economic and social benefits of energy efficiency measures.

A sustainable energy system may be regarded as a cost-efficient, reliable, and environmentally friendly energy system that effectively utilizes local resources and networks. It is not 'slow and inert' like a conventional energy system, but it is flexible in terms of new techno-economic and political solutions. The introduction of new solutions is also actively promoted [9].

The processes of extraction, conversion and utilization of energy are prone to wastages. The consequence of such wastage include: environmental degradation, faster depletion of energy resources, and increased cost of energy products and services. The concept of sustainable development therefore dictates that deliberate effort is made to promote efficiency in the production, conversion and utilization of energy. Energy resources and their utilization intimately relate to sustainable development. In attaining sustainable development, increasing the energy efficiencies of processes utilizing sustainable energy resources plays an important role [10].

This study will thus take a look at the various energy requirements of the various sectors visa-vis the energy conservation opportunities therein and also the measures to maximise these opportunities and thus conserve energy. The study identified some major areas through which energy conservation measures can effectively cause some savings in energy and allow for energy stability. The main area of focus for application of energy conservation measures considered in this study include: Manufacturing/industrial set-up; office and residential buildings, Transportation, power generation and distribution. Each of these areas is being examined for possible energy savings, building a sustainable, long – term, energy future in the country.

II. GENERAL FEATURES OF ENERGY ECONOMY IN NIGERIA

Energy is the mainstay of Nigeria's economic growth and development. It plays a significant role in the nation's international diplomacy and it serves as a tradable commodity for earning the national income, which is used to support government development programmes. It also serves as an input into the production of goods and services in the nation's industry, transport, agriculture, health and education sectors, as well as an instrument for politics, security and diplomacy [11].

Nigeria is richly blessed with primary energy resources. The country is endowed with the world's tenth largest reserves of crude oil currently estimated to be about 36 billion barrels (about 4.896 billion tonne of oil equivalent (toe)) in 2006. The country has also been described as more of a natural gas island than oil with an estimated endowment in 2006 put at about 166 trillion standard cubic feet (5,210 billion cubic meters). This includes associated and non-associated reserves, placing Nigeria among the top ten countries with the largest gas reserves in the World. Other significant primary energy resource endowment in Nigeria include: Tar sands ~ 31 billion barrels oil equivalent (4.216 billion toe); Coal and Lignite– estimated to be ~ 2.7 billion tonnes (1.882 billion toe); Large Hydropower Potentials ~10,000 MW; Small Hydropower Potentials, provisionally estimated to be ~ 734 MW. Table 1 below provides a brief summary of these endowments in Nigeria. The table contains recent estimates of other renewable potentials apart from hydropower [12].

Nigeria has an estimated coal reserve of 2 billion metric tonnes of which 650 million tonnes are proven reserves. About 95% of Nigeria's coal production has been consumed locally; mainly for railway transportation, electricity production and industrial heating in cement production. Apart from the export potential of the Nigerian gas, local demand opportunities are power generation, cement industry, iron and steel plants. The largest single consumer of natural gas in Nigeria is Power Holding Company of Nigeria Plc(PHCN) and it accounts for about 70% gas consumed to operate electricity generating gas plants in the country. The consumption rate of petroleum product in Nigeria has increased tremendously in 1990- 2004 with motor gasoline and diesel oil taking a significant lead. The consumption of petroleum products stood between 80% and 90% of the total commercial energy consumption over 35 years. The growth rate over the period averaged about 22 % with gasoline 28%,

kerosene 19% and diesel 18%. Gasoline and diesel are mainly used for transportation which accounts for 87% [13].

Despite the ample coal, oil and natural gas reserves, at the present rate of extraction, it has been estimated that, these reserves, by the next forty years, will be depleted to the point where it would be uneconomical to continue exploration. It becomes imperatives, therefore, that we start implementing energy conservation and efficiency measures in conversion systems while looking for alternative source of energy [14].

TABLE 1 NIGERIA'S ENERGY RESERVES AND POTENTIALS (2005)

Resources Type	**Reserves**	**Reserves (BTOE)[1]**
Crude Oil	36.0 billion barrels	4.896
Natural Gas	166 Trillion SCF[(2)]	4.465
Coal & Lignite	2.7 billion tonnes	1.882
Tar Sands	31 billion barrel of Oil equivalent	4.216
Sub – Total Fossil		15.459
Hydropower, Large Scale	10,000 MW	
Hydropower, Small Scale	734 MW	
Fuelwood	13,071,464 Hectares[(3)]	
Animal Waste	61 million tonnes/yr	
Crop Residue	8.3 million tonnes/yr	
Solar Radiation	3.5 – 7.0 KWh/m^2 - day	
Wind	2 – 4 m/s (annual average)	

Source: Ref 12

(1). BTOE: Billion Tonnes of Oil Equivalent (2). SCF Standard Cubic Feet (3). Forest Land Estimate for 1981

A. Energy Crises in Nigeria

Throughout the world electricity is the most widely used and desirable form of energy. It is a basic requirement for economic development and for an adequate standard of living. As a country's population grows and its economy expands its demand for electrical energy multiplies. If this demand is not met adequately a shortage in supply occurs. This shortage can assume crisis proportions [15]. According to Chigbue [16], electric power as a major component in the requirements for effective industrialization and development is grossly inadequate in Nigeria.

For many years now, Nigeria has been facing an extreme electricity shortage. This deficiency is multi- faceted, with causes that are financial, structural, and socio-political, none of which are mutually exclusive [17]. At present, the power industry in Nigeria is beset by major difficulties in the core areas of operation: generation, transmission, distribution and marketing [18].

In spite of Nigeria's huge resource endowment in energy and enormous investment in the provision of energy infrastructure, the performance of the power sector has remained poor, in comparison with other developing economies [19]. This assertion was confirmed by a World Bank [20] assessment study conducted on energy development in Nigeria, which compared the performance of Nigeria's power sector with those of 20 other developing countries. The study reveals that the sector had the highest percentage of system losses at 33-41 percent, the lowest generating capacity factor 20 percent, the lowest average revenue at US$ 1.56kWh, the lowest rate of return at 8 per cent, and the longest average accounts receivable period of 15 months.

There is no doubt that expensive and unreliable power remains a major concern to all sectors of the economy in Nigeria: the industrial, commercial, and domestic sectors especially. Multiple and unpredictable power cuts, which have become a daily occurrence in Nigeria, often result in equipment malfunctioning, which make it difficult to produce goods and provide service efficiently. As a result of this fundamental problem, industrial enterprises have been compelled to install their own electricity generation and transmission equipment, thereby adding considerably to their operating and capital costs [21].

Most businesses in Nigeria, large and small, end up relying on the generator for electricity to power their businesses. MTN – the South African mobile phone company and the largest mobile phone supplier in Nigeria – is estimated to have installed 6,000 generators to supply its base stations for up to 19 hours a day. The company spends $5.5 million on diesel fuel to run the generators [21].

B. Trends in Demand for Energy in Nigeria

There is an increasing demand for fuel energy due to the increase in economic development and civilization all over the world. Industry is one of the most important energy

consuming sectors in the world. According to Mitchel [22], energy is essential to our way of life. It provides us with comfort, transportation, and the ability to produce food and material goods.

Based on the models developed by Energy Commission of Nigeria (ECN) to analyze the country's energy sector for the period from 2000-2030 with the use of Model for Analysis of Energy Demand (MAED) and Wien Automatic System Planning (WASP) package (Table 2), it can be said that the energy demand of Nigeria will be approximately 2.5, 3, 3.5 and 4.5 folds between the years 2000 and 2015 and approximately 8, 13, 17 and 22.5 folds between the years 2000 and 2030 based on 7% (reference), 10% (high growth), 11.5% (optimistic) and 13% (optimistic) GDP growth rate per annum, respectively. This increase in demand for energy is due to the high level of economic activities expected in Nigeria as measured by the total GDP.

TABLE II TOTAL PROJECTED ENERGY DEMAND (MTOE)

Scenario	2000	2010	2015	2020	2025	2030
Reference (7%)	32.01	51.40	79.36	118.14	169.18	245.19
High growth (10%)	32.01	56.18	94.18	190.73	259.19	414.52
Optimistic (11.5%)	32.01	56.18	108.57	245.97	331.32	553.26
Optimistic (13%)	32.01	72.81	148.97	312.61	429.11	715.70

Ref. 23

TABLE III TOTAL ENERGY DEMAND BASED ON GDP GROWTH RATE (MTOE)

Item	2005	2010	2015	2020	2025	2030	Average growth rate(%)
Industry	8.08	12.59	26.03	39.47	92.34	145.21	16.2
Transport	11.70	13.48	16.59	19.70	26.53	33.36	4.7
Household	18.82	22.42	28.01	33.60	33.94	34.27	2.6
Services	6.43	8.38	12.14	15.89	26.95	38.00	8.7
Total	45.01	56.87	82.77	108.66	179.75	250.84	8.3

Ref. 23

The trends of projected energy demand are shown in Fig.1. In 2005, the total energy demand based on 10% GDP growth rate revealed that household segment had the largest share of all the sectors. The sectoral energy demands in the 2030 plan period however, showed the highest growth rates for the industrial, followed by the services, household and transport sectors in that order (Table 3). The electricity demand extracted from the total energy demand, shows an increasing trend from the base year 2005-2030 on the four adopted growth scenarios respectively as shown in Fig. 2, indicating a high economic growth rate leading to a substantial increase in electricity demand. The energy consumed over the years shows a decreasing trend with increasing population, necessitating a corresponding increase in energy output. Hence, the country's large energy efficiency potential needs to be exploited.

In 2007, the total primary energy consumed was 11.4 million tonnes of oil equivalent (mtoe) with petroleum products having the largest share of 67.3% of the total consumption amounting to a total average consumption of 78.7% between 2002 and 2007. This level of consumption was followed by that of hydropower at 23.9%, natural gas at 8.7% and coal at 0.05% with their respective total average consumption standing at 16.08, 5.17 and 0.04% for the 2002-2007 periods as shown in Table 4. Flaring, adversely reduced the maximum contribution of natural gas to the total energy consumption mix in spite of its huge deposit in the country because most of the oil fields lack appropriate infrastructure for gas production and the general Niger Delta security issue (bunkering, sabotage etc.) have also weakened most of the oil and gas projects [25].

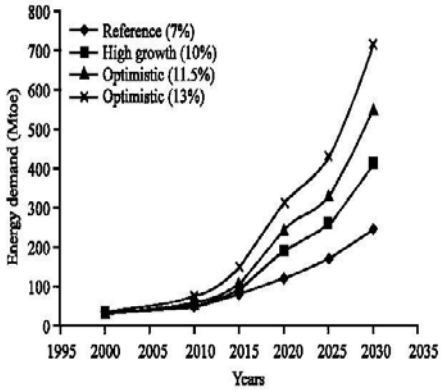

Fig. 1 Graph showing the projected electricity demand between 2000 – 2030

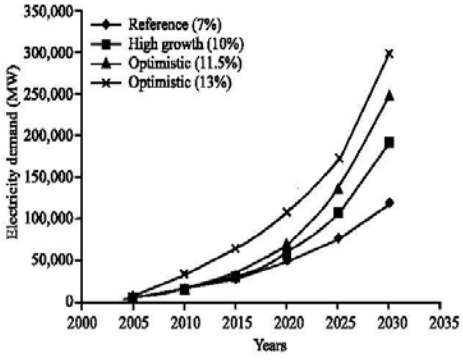

Fig. 2 Graph showing the projected electricity demand between 2005 -2030

TABLE IV COMMERCIAL PRIMARY ENERGY CONSUMPTION BY TYPE (AVERGY % OF TOTAL)

Type	2002	2003	2004	2005	2006	2007	Average
Coal	0.03	0.03	0.03	0.03	0.05	0.05	0.04
Hydro	11.93	14.20	17.39	12.04	17.03	23.90	16.08
Natural Gas	2.84	1.9	4.54	5.5	7.52	8.73	5.17
Petroleum Products	85.20	83.87	78.04	82.45	75.44	67.32	78.71

Ref. 26 & 27

As the country's population grows and its economy expands its demand for electrical energy multiplies. If this demand is not met, adequately a shortage in supply occurs. This shortage can assume crisis proportions [25].

According to Power Holding Company of Nigeria (PHCN), the existing generation in 2009 was put at a total installed capacity of 8702 MW (77.73% thermal and 22.27 % hydro), available capacity of 4825 MW (72.93% thermal and 27.07% hydro) and an operational capacity of 3149 MW (68.2% thermal and 31.8% hydro) with an availability factor of 0.55MW [28].

However, the electric power capacity demand by projection in Nigeria would be approximately three-half fold between 2010 and 2020 and seven-half fold between 2010 and 2030, respectively at 7% growth rate while the projected supply by fuel mix shows a similar trend with the demand at both the 7 and 13% growth rates (Table 5). This shows a wide disparity in the energy demand to supply in the country both in the present and the future. This necessitates an urgent need for alternative energy source and efficient energy usage in order to avert looming energy crises.

TABLE V ELECTRIC POWER CAPACITY IN NIGERIA (SUPPLY BY FUEL MIX AND DEMAND 7 AND 13% GDP GROWTH)

	Electric power demand											
	2010				2020				2030			
	Demand(MW%)		Supply(MW%)		Demand(MW%)		Supply(MW%)		Demand(MW%)		Supply(MW%)	
Fuel type	7	13	7	13	7	13	7	13	7	13	7	13
Coal	-	-	0	0	-	-	6.515	16.913	-	-	15.815	63.896
Gas	-	-	13.555	31.935	-	-	37.733	78.717	-	-	85.585	192.895
Hydro	-	-	3.702	3.902	-	-	6.479	6.479	-	-	11.479	11.479
Nuclear	-	-	0	0	-	-	3.530	11.005	-	-	11.872	36.891
Small hydro	-	-	40	208	-	-	140	1.000	-	-	701	2.353
Solar	-	-	5	30	-	-	34	750	-	-	302	4.610
Wind	-	-	0	500	-	-	1.471	3.971	-	-	5.369	15.567
Total	15.730	33.250	17.303	36.576	50.820	107.600	55.903	118.836	119.200	297.900	131.122	327.690

Ref. 23 & 24

These projections for continued rapid energy growth imply some severe problems for the future-resource depletion, energy degradation, associated environmental problems, fuel shortage etc. Indeed many of these problems are already happening, thus energy conservation is concerned with ways to reduce energy demand, but yet achieve the same objective as before. Therefore, to alleviate these problems and to sustain available energy resources in Nigeria, implementation of efficient energy utilization principle and energy conservation measures is the way forward.

III ENERGY EFFICIENCY PRACTICE IN NIGERIA

Energy is an important production factor and therefore should be managed in parallel with land, labor and capital. Energy efficient production should be seen as a quick and cheaper source of new energy supply as the cost of providing energy can be several times the cost of saving it. Increasingly energy efficiency is deemed to include not only the physical efficiency of the technical equipment and facilities but also the overall economic efficiency of the energy system [29].

Energy efficiency means improvement in practices 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 [30]. Energy efficiency is also defined as essentially using less energy to provide the same service [31]. 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.

On the other hand energy conservation defined as "an attempt to reduce the amount of energy used for domestic and industrial purposes" is obviously synonymous with energy efficiency. It has been described as using energy more efficiently, whether through behavior, improved management or the introduction of new technology [32]. Energy conservation is further defined as " the strategy of adjusting and optimizing energy using systems and procedures so as to reduce energy requirements per unit of output (or wellbeing) while holding constant or reducing total costs of providing the output from these systems" [29]. It has sometimes been associated with efforts to curtail energy use at the cost of economic activity and living standards, but it should be concerned exclusively with energy conservation as a means of increasing economic benefits. It can be seen from the various definitions and explanations that energy efficiency and energy conservation convey the same meaning and can be used interchangeably. The basic objective is the same - the reductions of energy costs or increase in energy supply.

Energy efficiency has become the key driver of sustainable development in many economies in the world [33]. Improving energy efficiency, i.e. obtaining more final energy services from less energy – is the surest and most direct way of increasing sustainability of the use of energy resources and decreasing the negative aspects – environmental pollution and financial costs – associated with using energy and producing goods. The economic potential of even more efficient energy use will continue to grow with new technologies and with cost reduction resulting from the economy of scale.

Presently, energy utilization in Nigeria is far from being efficient. Apart from the direct loss due to energy wasted, using energy inefficiently has three major implications in Nigeria. These are:

a) The investment in some energy supply infrastructure is far in excess of what the energy demand is;

b) The environmental problems associated with energy utilization are more aggravated due to large energy consumption;

c) Excessive energy consumption adds to the costs of goods produced especially in energy intensive industries like cement, steel works and refineries.

If we use energy efficiently, 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.

Increased energy efficiency would provide this country with significant economic, environmental, and security benefits. To make further progress toward a sustainable energy future, Administration policy should encourage investments in energy efficiency and fuel flexibility in key economic sectors. By focusing on market barriers that inhibit economic investments in efficient technologies and practices, the energy efficiency program would help market forces continually improve the efficiency of our homes, our transportation systems, our offices, and our factories.

A. Energy Efficiency Policy in Nigeria

The national Energy Policy and the draft energy masterplan contain basic policies and strategies for energy efficiency and conservation in Nigeria. In specific terms the policy provides for:

- The promotion of energy efficiency and conservation in industrial, residential and transport sectors.
- Designing a National Programme on Industrial Energy Efficiency and Conservation in collaboration with MAN and experts in higher institutions and research centres.
- Introduction of fuel efficiency labelling programme in the transportation sector for various vehicle types
- Establishing Codes and Standards for energy efficiency and conservation technologies.
- Enforcing the Codes and Standards.

This policy is only on paper but never implemented so as to promote practice of energy efficiency and energy conservation principle in the country.

B. Inefficient Utilization of Energy in Nigeria

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**.** Energy is used wastefully in virtually all sectors in Nigeria. Excessive waste is a sign of an unsustainable technology. In Nigeria a lot of energy is wasted because households, public and private offices and industries use more energy than is actually necessary to fulfil their needs. One of the reasons is that they use old and inefficient equipment and production processes. The other reasons are unwholesome practices that lead to energy wastage. These are discussed in this section.

1) Use of Inefficient Traditional Three Stone Fuel Wood Stoves:

For most Nigerians, cooking is the most important energy need. Fuel wood was found to be the predominant energy source in the household sector with about 70-80% of households depending on it as their cooking fuel in both the remote villages and the towns with the use of inefficient earth stove (traditional three stone stoves) with efficiencies of between 5 to 12%. The consequences of this to the natural environment are that unchecked felling of trees to provide the fuel wood requirements will exacerbate desert encroachment, soil erosion and loss of soil fertility problems.

2) Use of Vehicles with Low Fuel Efficiency:

In Nigeria, nearly all vehicles are imported from overseas, often used cars and trucks. Fuel efficiency is low because the vehicle fleet is old and poorly maintained, because of traffic congestion in most urban centres, and because of bad driving habits. Energy savings of 30 percent could be achieved in the

road subsector by shifting from an energy-intensive transport mode to a less energy-intensive public transport system and by adopting traffic management schemes.

3) Dominant Use of Incandescent Light Bulbs:

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. 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. Energy consumed in Nigeria can be drastically reduced if Nigerians replace their incandescent bulbs with energy efficiency bulbs.

4) Indiscriminate Use of Electricity among Urban Dwellers in Nigeria:

In many major cities in Nigeria, indiscriminate use of electricity for different purposes is common. These include putting on light to advertise goods in the day time, switching on outdoor lighting during the day, building of industries in residential areas, proliferation of private water boreholes, setting appliances on standby mode, simultaneous use of multiple appliances in public buildings, leaving appliance on when not in use, multiple use of inefficient heating equipment for cooking and heating water in the residential and commercial buildings etc. All these practices encourage the wastage of electricity and bring about inefficient utilization of energy.

5) Purchase of Second-hand Appliances:

The Nigerian market is flooded with all kinds of second-hand appliances. Over 90% of Nigerian use one second-hand product or the other. They are cheaper compared to the new ones. Many Nigerians are on the opinion that second-hand 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 second-hand goods tend to last longer than them. Many of the second-hand 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 second hand market needs to be further studied to direct policy that will address the situation.

6) Gas Flaring:

Gas flaring also has significant negative impacts on the environment, not least due to its climate change impacts. Associated gas has been flared since the start of oil production in the Niger Delta. Nigeria flares about 2.5 billion cubic feet (over 70 million m^3) of gas per day. In other words, 40 percent of its annual gas production accounts for 12.5 percent of all globally flared gas). This amounts to about 70 million tonnes of carbon dioxide [34]. Apart from causing a direct loss in energy sector, gas flares have detrimental effects on the environment. It releases toxic substances, including benzene and particulates, which damage the human immune system and increase the acidity of rain. Health risks include child respiratory illness, asthma and cancer. Households that rely on traditional livelihoods such as fishing and crop production have suffered due to negative impacts on fish and vegetation.

C. Barriers to Energy Efficiency Development in Nigeria

The major barriers militating against the adoption of more energy efficient practices in Nigerian can be dignified as follows:

- **Policy Barriers:** Policies to encourage, promote and incentivise energy efficiency are absent;
- **Regulatory Barriers:** There are no codes and regulations to groom energy efficiency programs;
- **Lack of Adequate Institutional Frameworks:** There is no agency for formulating, coordinating, implementing, and monitoring energy conservation policies and programs;
- **Lack of Information:**

The general public is not aware of the benefits of energy efficiency;

There is no database of energy use in the sectors of the economy;

- **Lack of Local Manufacturing Base:** The level of local manufacturing is very low and most equipment/ appliances are imported;
- **Financial Barriers:** Funds are not available to finance energy efficiency projects;
- **Capacity Barriers:** Trained manpower to evaluate, certify, implement and enforce energy efficiency measures is grossly inadequate;
- **Inefficient Energy Pricing Policies:**

Electricity tariffs and prices for petroleum products are highly subsidized;

Subsidy discourages energy efficiency practice

D. Promoting Energy Efficiency in Nigeria

In Nigeria since 2003, the Energy Commission of Nigeria in collaboration with the United Nations Industrial Development Organization and other stakeholders has made steady progress in awareness creation in the area of energy efficiency programs. Train-the-trainers energy audit workshops were organized in 2003/2004 with experts drawn from UNIDO Vienna and ADEME in addition to energy audit walk-through of many key industries. Several national and international energy efficiency workshops have been conducted by the commission. In pursuance of its mandate, the Energy Commission of Nigeria has produced an energy master plan with energy efficiency at the centre of its activities. To give effect to the urgent need for energy efficiency programs in Nigeria and to accelerate implementation programs, a national center for energy efficiency was recently established by the commission at the University of Lagos Nigeria. Activities in the area of energy efficiency rose to a high in 2009 when the Commission in collaboration with the Cuban government embarked upon the replacement of highly inefficient incandescent light bulbs with compact fluorescent lamps at the domestic level in different parts of the country. The program which is still on-going has been followed by massive national energy efficiency awareness campaign workshops and energy audit walk through covering public buildings, various types of industry-petroleum, petrochemical, aspects of industry operations and

the domestic sector.

The overall aim of the workshops has been to raise national awareness on industrial, institutional and household energy savings potentials in meeting national energy demand in Nigeria.

Based on the benefits of implementation of energy efficiency, there is need to promote energy efficiency in Nigeria. Not only are there many ways to use energy much more efficiently, there are also many ways to promote this strategy, including (1) education, (2) taxes on fossil fuels, (3) feebate systems (which levy a tax on those who choose energy-inefficient options and give rebates to those who opt for energy-efficient technologies), (4) government-mandated and implemented the existing energy efficiency programs, (5) voluntary programs, (6) changes in pricing, and (7) least-cost planning.

Promotion of energy conservation and efficiency is important in all sectors in order to save energy, money and protect the environment.

IV. ENERGY CONSERVATION AND SUSTAINABLE DEVELOPMENT

Energy conservation is a tangible resource by itself that competes economically with contemporary energy supply options. In addition to this, it offers a practical means of achieving four (4) goals that should be of high priority in any nation that desires quick and sustainable economic growth and development [35]. These are economic competitiveness, utilization of scarce capital for development, environmental quality, and energy security. It enhances international competitiveness of industry in world markets by reducing the cost of production. It optimizes use of capital resources by directing lesser amounts of money in conservation investment as against capital-intensive energy supply options. It protects the environment in the short run by reducing pollution and in the long run by reducing the scope of global climate change. It strengthens security of supply through lesser demand and lesser dependence on petroleum products imports. No energy supply option may be able to provide all these benefits. Energy conservation is a decentralized issue and largely dependent on the individual, unlike decisions of energy supply which are highly centralized. The housewife, the car driver, the house developer, the house owner, the boiler operator in industry, and every other individual who consumes energy in some form or the other are required to participate in energy saving measures. It calls for a collective endeavour, in that it stems from the actions of people in diverse fields although the people involved may not be sufficiently informed or motivated to conserve energy.

Energy conservation is vital for sustainable development, and for the best benefit of the present and future generations it should be implemented by all possible means. A secure supply of energy resources is generally agreed to be a necessary but not sufficient requirement for development within a society. Furthermore, sustainable development demands a sustainable supply of energy resources that, in the long term, is readily and sustainably available at reasonable cost and can be utilized for all required tasks without causing negative societal impacts. Supplies of such energy resources as fossil fuels (coal, oil, and natural gas) and uranium are generally acknowledged to be finite; other energy sources such as sunlight, wind, and falling water are generally considered renewable and therefore sustainable over the relatively long term.

Taking into consideration the importance of energy conservation, the relation between energy conservation and sustainability is presented in Fig. 3 . From Fig. 3, it is shown that energy resources and their utilization are intimately related to sustainable development. For societies to attain or try to attain sustainable development, much effort must be devoted not only to discovering sustainable energy resources, but also to increasing the energy efficiencies of processes utilizing these resources.

Many energy conservation and efficiency improvement programs have been and are being developed to reduce the present levels of energy consumption. To implement these programs in a beneficial manner, an understanding is required of the patterns of "energy carrier" consumption, such as the type of energy carrier used, factors that influence consumption, and types of end-uses [36].

In spite of the potentially significant benefits of energy conservation program to the economy and their proven successes in several countries, conservation programs have not yet been undertaken on a significant scale in Nigeria. Some reasons for this lack of energy conservation programs relate to the following factors:

- Technical (e.g., lack of availability, reliability, and knowledge of efficient technologies)
- Institutional (e.g., lack of appropriate technical input, financial support, and proper program design and monitoring expertise)
- Financial (e.g., lack of explicit financing mechanisms)
- Managerial (e.g., inappropriate program management practices and staff training)

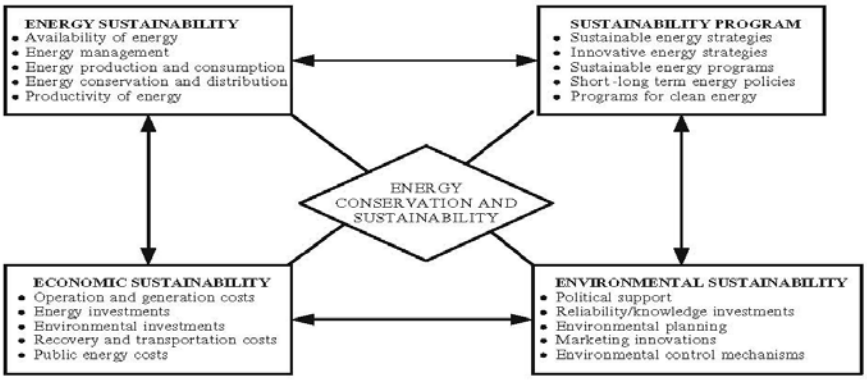

Fig. 3 Linkages between energy conservation and sustainable development

A. Opportunities for Energy Conservation in Various Sectors

The need for energy is increasing and outstripping its supply in Nigeria. Therefore, and in view of these circumstances primary energy conservation, rationalization and efficient use is an immediate need. Getting all the possible energy from the fuel into the working fluid is the goal of efficient equipment operations. This saves money, produces higher productivity and not only this, it also influences the safety and life of the equipment and reduces pollution [37]. Steps taken to minimize energy consumption, or to use the energy more effectively, are steps in the right direction to preserve the global environment. Energy conservation measures or recommendations are often referred more positively as opportunities. Two primary criteria for energy conservation opportunities are that it be easy to implement and that its payback be short. Ease of implementation and payback period has been used to classify Energy conservation opportunities into 3 general categories: maintenance and operation measures, process improvement projects, and large capital projects [38].

Although energy conservation and efficiency are not resource per se, it is acknowledged that their adoption in the country can significantly mitigate the supply challenge. It is in recognition of this that the Federal Government of Nigeria recently approved the establishment of a National Centre for Energy Efficiency and Conservation [39]. The Centre is charged with the responsibility for organizing and conducting research and development in energy efficiency and conservation. In this regard, the Centre is to carry out the following functions:

(i) Develop guidelines for energy efficient end-use products and advise on their implementation;

(ii) Develop energy efficiency codes, standards and specifications for domestic, industrial and commercial facilities;

(iii) Gather, analyze and manage energy supply and consumption data and information;

(iv) Serve as a Centre for training of high level manpower in energy efficiency and conservation;

(v) Develop and execute pilot/demonstration project highlighting energy efficiency concepts;

(vi) Disseminate information on energy efficiency and conservation concepts through public awareness programmes such as seminars, workshops, publications, etc;

(vii) Perform any other functions, as may be directed by the Federal Government in relation to energy efficiency and conservation in Nigeria.

In Nigeria energy is used so inefficiently, huge cuts in energy demand can be made by applying appropriate efficiency and conservation measures. This should not affect the level of services we receive. Much of our future energy demand can be met by freeing up energy currently wasted in three major economic sectors: transportation, buildings (residential and offices), and manufacturing /industrial set up.

1) Opportunities for Energy Conservation in Buildings:

If the building envelope and building materials were adequately taken care of to allow for a longer time period for daylighting, and maximum indoor space cooling, this would reduce the time of need of electrical energy for both lighting and cooling devices. Consequently, this will promote energy conservation. Apart from the building envelope, a lot of opportunities also exist for energy conservation in the lighting and cooling devices sub-sectors. For instance, due to the high first-cost of fluorescent bulbs, incandescent bulbs (40 Watts and 60 Watts rating) are still the pre-dominant electric lighting device in the country. Hence, approximately 34.3% of total electricity use in urban households goes to lighting [40] . The tropical climate of Nigeria definitely makes spacecooling an essential energy service. This is provided by electric fans and air conditioners. Fans have a much higher market share than air conditioners in Nigerian households because of their lower investment costs and lower electricity consumption. A study [40] has revealed that electricity consumption by fan cooling ranges between 2% and 8% while the total average consumption is 7% of the total household electricity consumption in the various household income groups in the country. Similarly, the percentage share of electricity consumption by air conditioners to the total household electricity consumption ranges between 0% and 2% with a total average of 1.5%. Resulting from the downturn in economy in the past two decades, the Nigerian market has become a dumping ground for second hand products from abroad. Definitely, due to overuse before shipment, the efficiencies of these products have dropped. These consequently promote energy inefficiency in our buildings. If better energy efficient lighting devices such as the compact fluorescent lamps (CFL) as well as better energy efficient cooling devices – fans and air conditioners were promoted in the country, these would help in reducing both electric lighting and cooling energy. Putting all these energy savings opportunities in the residential buildings alone together, it is estimated that at least 10% of total residential electrical energy use will be conserved. Similarly, about 10% of both total industrial and commercial sectors' electricity demand could also be saved. Ultimately, these would lead to a reduction in greenhouse gases emissions in the country.

2) Opportunities for Energy Conservation in Industries:

Electricity from Power Holding Company Nigeria Plc (PHCN) dominates the energy supply for the industrial sector in Nigeria. This is supplemented by electricity generating sets that are fuelled by automotive gas oil (diesel). High and low pour fuel oils are used in textile, cement and brick manufacturing plants. The foregoing is for large industries which are mostly located in the big cities and towns.For the small towns and villages, the bulk of the small-scale industries are operated on diesel generators for bakeries, small-scale steel works, small-scale ceramic/pottery works etc.

The industrial sector is extremely diverse and includes a wide range of activities. This sector is particularly energy intensive, as it requires energy to extract natural resources, convert them into raw materials, and manufacture finished products. The industrial sector can be broadly defined as consisting of energy-intensive industries (e.g., iron and steel, chemicals, petroleum refining, cement, aluminium, pulp and paper etc) and light industries (e.g., food processing, textiles, wood products, printing and publishing, metal processing etc) [41] .

Strictly speaking, two forms of energy carriers are commonly used in the industry: electricity and heat. However,

among all the energy forms, electricity is the most widely deployed in the industry for the transformation of raw materials into the desired end products. Electricity consumption in the industry is usually for lighting and motor power-drives of various kinds of equipment, such as pumps, fans, compressors, blowers, conveyors, air conditioners and various machine tools. It is also used in electric furnaces and electrolysis. Improvement in the efficiency of electric motors in particular can result into large energy and cost savings. On the other hand, thermal energy is mostly used in boilers for process steam generation and in kilns such as in cement production [29].

In Nigeria, energy savings opportunities in the industrial sub-sector of the economy have remained a matter for speculation over the years due to uncoordinated efforts addressing issues relating to energy efficiency and management. It is in the bid to create necessary awareness on the huge potentials for energy savings in the sector that Energy Commission of Nigeria in collaboration with UNIDO and other stakeholders have for some time now engaged themselves in industrial energy efficiency programs in Nigeria.

Studies indicate that good housekeeping measures can save substantial amounts of energy in Nigerian industries. Potential energy savings in national industries range from 15–32 percent by 2020 [42]. Results from energy audits in Nigeria (of two cement plants, one steel plant, and a furniture manufacturing plant) show potential savings of up to 25 percent [42]. Investigation carried out recently in some industries in Nigeria reveals areas of energy conservation (savings) in Nigerian industries.

Below are highlights of walk-through energy audits of some industries in Nigeria.

Food Industries: Study on pattern of electrical energy consumption from 210 selected micro and small-scale food and beverage companies in Nigeria was carried out by [43]. The study showed that the pattern of electrical energy consumption in the food companies was mainly from generating set; this was due to either low voltage or epileptic power supply from national grid. Direct and indirect sources that lead to electrical energy waste and in-efficient energy utilization in the industry were identified as energy loss as a result of worn out or slack / misaligned belts that need timely replacement or tensioning, training and retraining of staff, power factor of electrical equipment among others. Three out of eleven strategies were effective in reducing the companies' electricity bill by 3% for the same quantity of production. These include: switching off most lighting during day time; instant replacement / tensioning of worn out / slack belts or chains and; disconnection of all faulty equipment. This finding shows that 72.8% of all the acclaimed strategies to reduce energy consumption were not effective. The study concluded that the factors constituted electrical energy waste and energy use inefficiency in the food companies in the study area were very identical and recommendations for effective energy use efficiency in the firms were proposed.

In the bottling company: in this industry, it was observed that the electricity supply is 100% from 3No 800kVA diesel generators while thermal energy for the boiler is from low pour fuel oil (LPFO). Two out of the three diesel generators are run at a time (24hrs/day) and the other stays on standby. To say the least, this scenario is replicate of most industries in Nigeria which is indeed a sad commentary of the electricity supply situation in the country. In terms of energy efficiency, the compounding wastes along the energy supply line are better imagined.

The scenario in the bottling company in relation to energy efficiency is that, a 10 bar, 2 metric ton per hour capacity, low pour fuel oil fired steam boiler, produces steam at a pressure of 4-5 bar (about 140^oC-150^oC) use in bottle washing that requires hot water at temperature of about 80^oC-90^oC. It was observed that the steam produced at a high temperature of about 140^oC has to be throttled to reduce the temperature to the required level for bottle washing. Ironically the runoff water from the final washing stage comes out at a temperature of 60-70^oC and is emptied into the drain. While this practice is considered proper from point of view of avoidance of contamination, it is suggested that a low pressure steam boiler operated at 2 bars can meet the steam requirement and thus save thermal energy.

Furthermore in the compressed air unit, the water-cooled single stage compressor delivers at a temperature of about 80^oC while the cooling water comes off at 60^oC and is again let off the drain. Opportunity for energy efficiency here is that the heat of the air compression can be recovered to heat the boiler feed water and this may result to about 5% energy savings.

Chemical Industry: In this industry the source of electricity used in this factory includes: a 1,250KVA gas generator that runs for 24hrs except when it is under maintenance, a 1000KVA diesel generator is used to support the main generator during repairs, also a 153KVA diesel generator used to run the factory when there are no activities, a 500KVA transformer connected to PHCN to generate electricity. Walk-through energy audit carried out in this industry reveals the following areas of energy savings opportunities: replacement of high capacity generators with smaller capacity generator for load shedding as this will minimize energy wastage. A lot of energy is wasted as the high capacity generators are not fully utilized; replacement of the large number of high pressure sodium bulbs with energy efficient CFLs; replacement (especially large) of standard electric motors with high efficiency types (especially in the mill-hopper section); Installation of heat-reclamation equipment – economizers and air heaters for flue gas and heat exchangers / heat pumps for boiler blow down.

In the beer manufacturing company: the investigation reveals the following areas of energy savings opportunities: In the De-aerator – copious amount of steam loss from the deaerator by deliberate action of operators; steam line leakages from loose joints and holes along the piping network; the Wort Kettle- Loss of latent heat in the evaporation of water from the kettle; exposed steam lines- Radiation loss from un-insulated parts; boiler fuel-not sufficiently atomized for efficient combustion; boiler which is oversized and which operates on part load most of the time; cooling Tower- treated water allowed to over flow and thick ice formation along NH_3 pipeline; brine motor pump-Use of constant speed motor drive which run continuously even at no load; large quantity of water waste at the bottle cleaning section; boiler TDS not monitored, feed water make up not measured and condensate not recovered; generator frequency low at 47Hz and power factor low at times.

3) Opportunities for Energy Conservation in Transport Sector:

The transport sector is the third largest consumer of energy after the industrial sector. The share of energy consumption from transport sector varied from about 13% to about 18% from 1996 to 2005 [44]. In terms of consumption of petroleum products it is by far the largest consumer sector, and is therefore the sector with the highest impact in terms of foreign exchange costs. Thus, energy saving in this sector is of high priority particularly in financial and economic terms.

In Nigeria, many factors are responsible for high consumption of energy (fuel) in transport sector. Some of these factors are: owing of fleet of vehicles by the rich people and government officers (political leaders); purchasing of second hand ('Tokunbo') vehicles; use of inefficient and uneconomic vehicles; use of vehicle with old engine; bad road network etc.

To reduce energy consumption and green house gas emissions, the Government has to implement the following recommendations:

- Introduce mass transport services as operate in some cities in the country: shift road freight to rail and from small vehicles to large vehicles.
- Promote the use of non-motorised transport (bicycles and pedestrian) for short distance.
- Promote availability of spare parts for maintaining efficient operation.
- Continuing improvement of road network: continued efforts should be made to upgrade the road network particularly between the secondary towns, as this not only improves socioeconomic activity, but also reduces energy demand.
- Decentralise industrial development: industrial investment should be encouraged by fiscal measures and following the pattern of secondary town development to avoid creating centralised industrial conurbation far from the location of the labour force, with resultant high transport requirements.
- Facilitate for railway rehabilitation: High priority should continue to be given to the restoration of the railway and the use of its terminal as an inland port for urban areas in Nigeria.
- Shift freight transport from road to rail, and from using small vehicles to large ones.
- Standardise imported vehicles with respect to energy efficiency and environmental safety.

B. Energy Conservation Measures in Nigeria Economic Sectors

Energy conservation measure in office and residential buildings: Possible energy conservation measures in office and residential buildings include: (1) proper building orientation and symmetry. Building design should permit most of the spaces to be day lighted. Using day lighting reduces energy consumption by replacing electric lights with natural light. Buildings designed for day lighting typically use 40-60% less electricity for lighting needs than do conventional buildings; (2) provision of enough windows for cross ventilation. In very hot climates ventilation is very important. This will go a long way in reducing the use of air conditioners at homes and offices. Although sunlight and daylights are free and readily accessible, however, their use without causing glare and overheating can be difficult. Glare can be avoided by using window sills, louvers, reflective blinds and other devices to reflect light deep into the buildings. Thus windows with selective glazing that transmit the most visible light while reducing solar heat should be favoured. Considerable saving potentials for energy in Nigerian office and residential buildings is possible through cost effective building design.

Lighting: Possible energy conservation measures through lighting in offices, homes, commercial centers and industries in Nigeria include: (1) relamping: relamping means substituting one lamp for another to save energy. New fixtures are available which produces superior energy savings, reliability and longevity compared with incandescent lamps. Compact Fluorescent Lamps (CFLs) are generally considered best for replacement of lower incandescent lamps at homes, offices, commercial and industrial outfits. These lamps have efficacy ranging from 55-65 lumens $Watt^{-1}$. The average rated lamp life is 10.000 h, which is 10 times longer than that of a normal incandescent. They offer excellent colour rendering properties in addition to the very high luminous efficiency. Also, they offer energy savings potential; (2) installing lighting control systems, in bathrooms, stores and bedrooms: lighting controls are devices for turning lights on and off or for dimming them. There is the need to install lighting control systems such as photocells, timers, occupancy sensors and dimmers in bathrooms, stores, bedrooms and other not frequently used areas. This is to avoid wastage of energy in these areas; (3) street light control: street lighting accounts for more than 50% of all electricity consumed in Nigeria. Of this value about 50% or more of the energy is wasted by obsolete equipment, inadequate maintenance, or inefficient use. Saving lighting energy requires either reducing electricity consumed by the light source or reducing the length of time.

Energy conservation measures in manufacturing and industrial processes: Three prominent broad areas had been identified for energy conservation measures in manufacturing and industrial processes in Nigeria. These include: (1) improved housekeeping: improved house keeping with such factors as furnace maintenance, adjustment of lighting system operations, use of daylight, improving space conditions for lighting and improving lamp and fixture efficiency are quantifiable measures of energy conservation; (2) recovery of waste: this forms significant savings in energy through recovery of waste heat - flue gas, exhaust steam, co-generation of electricity etc. Heat reclamation is the recovery and utilization of energy that is otherwise wasted, which can be a substitute for a portion of the new energy that would normally be required for heating cooling and domestic hot water system. Heat recovery conserves fuels, reduces operating costs and reduces peak loads; (3) technological innovation: this border on major redesign of processes and products to yield greater efficiency of cycle operations.

Energy conservation measures in transportation: Possible energy conservation measures in transportation in Nigeria include: (1) increasing the efficiency of the vehicle system through proper vehicle maintenance for better engine performance (2) rationing: techniques used in rationing include restricting the uses of an item-for example, forbidding the use of gasoline to power pleasure boats; limiting the number of vehicle to be owned by every citizen to one, setting a maximum amount a person can spend for fuel (petrol or

diesel) etc. **(**3**)** improved technology through electric cars: These are automobiles propelled by one or more electric motors, drawing power from an onboard source of electricity (Wikipedia). Electric cars are mechanically simpler and more durable than gasoline-powered cars, stores its energy on board, typically in batteries, but alternatively with capacitors or flywheel storage devices. Or it may generate energy using a fuel cell or generator; they produce less pollution than do gasoline-powered cars. Energy conservation in electric cars, however, is so important that engineers found a way to recover the heat and use it for other heating purposes; (4) encouraging people to use mass transport system and use of alternative energy source e.g., fuel- cells.

Energy conservation measures in household appliances: Possible energy conservation measures in household appliances in Nigeria include: (1) conserving electricity through air conditioners: check and clean the air-conditioners filter once a month; make sure the air conditioning unit is the proper size for the room it is cooling; locate the air conditioner on the north or east side of a house in a shady area; ventilate the house's attic to reduce heat building up; install ceiling fans to improve air circulation; (2) refrigerators: check door seals to make sure there are no air leaks; clean condenser coils on the back of the refrigerator; keep refrigerator away from oven or dishwasher and give the unit breathing room; turn thermostat down to 2.8^{o}C; turn on energy saver switch; (3) water heater: lower the heater setting to 49 – 54 ^{o}C; insulate the water heater and any exposed hot water pipes; use low-flow shower heads; (4) computers: turn off computers when not in use or set the computer to energy-saving mode; (5)cloth washers and dryers: use only with a full load; use warm or cold water, reserving hot water use only for heavily soiled clothes; use only full loads for the dryer and if a second load is necessary, dry that load immediately after the first to retain as much heat as possible; clean lint filter before each load; (6) ovens and stove: use microwave instead of oven where possible; food in glass dishes can be cooked at lower temperature; preheating oven is usually unnecessary; on the stove top cook with covered pans and match pan size to the size of the burner.

Energy conservation measures in power generation and distribution: This involves improvement in energy conversion technology for better efficiency, use of thermionic, thermoelectric in magneto-hydrodynamic generators for better fuel saving.

Energy conservation measure through research and development: The Department of Energy has responsibility for energy research. These programs, now distributed among a number of departments within the DOE, are concerned mainly with scientific and engineering research. They aim to develop better and cleaner methods for extracting and burning traditional fuels, such as coal and oil and also to develop new sources of energy, such as solar power, liquid fuels from biomass and nuclear fusion.

In Nigeria Demonstration plants have been funded for technologies such as coal liquefaction and coal gasification, fluidized-bed combustion of coal [45, 46] and improvement of methods for extracting oil from shale. Other concepts being explored are the conversion of solid waste into methane gas, the extraction of natural gas from coal seams, the use of fuel cells, magneto-hydrodynamics, wind energy and ocean thermal energy. Solar power research is being pursued in connection with efforts to design residential and commercial buildings that will use energy more efficiently. Some of the most promising devices are solar collectors (which employ water heated by the Sun), solar mirrors and photovoltaic cells capable of directly converting the energy of sunlight into electricity [46]. Improvement can be done through Government assistance by releasing funds regularly for the energy research institutes in the country.

V. CONCLUSIONS

Energy is an important production factor and therefore should be managed in parallel with land, labor and capital. Energy efficient production process should be seen as a quick and cheaper source of new energy supply as the cost of providing energy can be several times the cost of saving it. Increasingly energy efficiency is considered to include not only the physical efficiency of the technical equipment and facilities but also the overall economic efficiency of the energy system. Hence the adoption of energy efficiency measures in the major economic sectors (household, industrial and transport) in Nigeria will enhance profitability, reduce greenhouse gas emissions, promote sustainable development, and improve corporate social responsibility. The time to begin aggressive campaigns for energy efficiency measures in the Nigeria economy chain is long overdue.

From the energy outlook of Nigeria as revealed in this study, energy utilization in Nigeria is far from efficient because: forest and woodland reserves are being depleted for heating and cooking purposes using stoves of efficiency less than 10%; oil extraction process includes a lot of waste in the form of spillage resulting in serious environmental problems; continuous flaring of large volumes of natural gas in the oil fields of the Niger Delta is worsening the energy supply situation; inefficient electrical appliances (lighting, refrigeration, air conditioning, motors, fans, etc), especially in the residential, commercial and industrial sectors in the face of inadequate supply has aggravated the demand-supply energy imbalance. It is very clear from this study that, energy demand is very high and is increasing geometrically while the supply remains inadequate, insecure, and irregular and is decreasing with the years; the mix has hitherto been dominated by fossil sources which are fast being depleted apart from being environmentally non-friendly. The energy efficiency principle and conservation measures should be implemented and promoted in the country to checkmate this problem.

Presentation on the opportunities that are available in conserving energy in our various sectors – office building and residential areas, manufacturing industries, transportation, electricity generation and distribution, electricity equipment and appliances has been made in this work. The various areas where savings in energy can be made have been identified in this study, these include: energy use in heating and ventilating equipments, lighting, cooking, transport, electrically operated industrial machines and heat engines such as pumps, motors, fans, boiler, etc. Several guideline and measures have been suggested to conserve energy in these areas and if the guidelines and measures are strictly adhered to, substantive savings in energy will be made.

In order to ensure the sustainability of energy supply and subsequently of the country's sustainable economic development, the government has to intensify further the implementation of energy efficiency programme.

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