Energy efficiency and conservation: a positive step towards sustainable economic growth of Nigeria.

G.N Osaghae, H. Ahidjo, A.M Umar

Energy Commission of Nigeria

Plot 701C Central Business District

P.M.B 358 Garki, Abuja.

Corresponding Author: georgenosa@yahoo.com,

Abstract

The growth, prosperity and security of any Nation depend, to a large extent, on the adequacy, efficiency and functionality of its electricity industry. Unreliable power supply constitutes a major challenge to Nigeria's economic growth and development, hence solving the lingering electricity problem is critical to realizing the nation's quest to become one of the 20 largest economies of the world by 2020 and also becoming a preferred investment destination in Africa.

Over the past two decades, the stalled expansion of the national grid coupled with the high cost of diesel and petrol have affected growth of the nation's productive and commercial industries. While erratic and unpredictable nature of electricity supply have engendered a deep and bitter sense of frustration across the country, especially in the urban centres, due to this development,

It is on this premise that the various government organs like the Energy Commission of Nigeria embarked on survey on the promotion of energy efficiency and conservation in collaboration with international bodies such as ECOWAS, UN and CUBAN government as short term measure put in place to mitigate and cushion the effect of short supply of energy on the socio-economic development of Nigeria preventing its wastage in order to achieve Vision 20:2020.

Nigeria power supply is currently put at 4477MW which is grossly inadequate to drive industrialization as 26,561MW estimate is required in the next 8 years in order to meet demand as envisioned in vision 20:2020. This paper analyses the energy crisis in Nigeria and highlights the contribution of energy efficiency and conservation towards a sustainable development of Nigeria.

Keywords: Energy efficiency, conservation, power supply, Cfl, IL, renewable, sustainable growth

1. Introduction

For more than past five decades which Nigeria has attained her independent as a nation, the country has been striving to develop itself in every field of human endeavours employing every tools at its disposal. Recently, the country put in place the vision 20: 2020 as one of its strategic tool towards becoming one of the top leading 20 largest economies in the world and more importantly to consolidate its leadership position in Africa and establish itself as a force to be reckon with in the global economy and politics.

In order to achieve the set vision, the leadership of the country has been advised by the Accenture, the official Consultants on the vision to focus on the development of five key elements of economic growth and sustainable development namely (i) manpower, (ii) capital resources, (iii) technology, (iv) basic infrastructural facilities and (v) innovations. Following from above, it is realized that power supply in any country determines the pace of national development and the citizens' quality of life. In fact, in a country like Nigeria, it can be inferred that Electricity supply has the tendency of having major influence on the progress towards the attainment of its Millennium Development Goals (MDGs) which are aimed at reducing poverty worldwide as it drives the sectors which contributes meaningfully to the country's GDP. The sector also provides the infrastructure that supports other sectors of the economy. Strategically, the Federal government of Nigeria in realization of the significant role of Power

supply in stimulating the economy and sustainable development, decided to deregulate the sector.

NIGERIA has emerged the country with the biggest gap between supply and demand for electricity in the world, according to the progress report on the roadmap for power sector reform. The report, released recently by the Presidential Task Force on Power (PTFP), put electricity supply in Nigeria at 4477MW megawatts (mw) for a population of over 150 million people. It said the supply was not adequate to stimulate economic growth. Going by the roadmap implementation report, additional 7,770mw of electricity would have been added to the current 4477MW by the end of 2013.

According to the report, 'since Independence, Nigeria's power sector has operated as a state monopoly, where only the Federal Government invests in the generation, transmission and distribution of electricity. It has also been responsible for the procurement, construction, operation and maintenance of all power sector infrastructure and services required to support the sector. This centralization could not supply adequate power to keep pace with economic and population growth.

'There was severe underinvestment, equipment was poorly maintained and low salaries could not attract new talents. Today, Nigeria has the biggest gap in the world between electricity demand and supply, providing its population of 150 million with roughly 4000 megawatts of electricity. In contrast, South Africa generates 40,000 megawatts for a population of 47 million, while Brazil generates 100,000 megawatts for its 201 million citizens.'

The task force, has however, projected that the National Independent Power Projects (NIPP) would add about 4,770MW to the national grid, while the Independent Power Plants (IPP) would deliver additional 3,000MW , totaling 7,770MW by December 2013. It however, opined that the Roadmap for Power Sector Reform was a bright light at the end of the tunnel of more than three decades of underinvestment and inefficiency in Nigeria's power sector, noting that about 70 per cent of power supply in Nigeria currently comes from state-owned power plants.

'With reform, 70 per cent of power supply will come from the private sector in the next three to four years. Reform of the power sector can easily bring tens of billions of Foreign Direct Investment (FDI) into the Country, much more than the government has ever invested and can afford to invest in the sector. As our experience with telecommunications has proven, Nigerians can take the availability of power for granted and lay the foundations for industrial growth by letting the government focus on nurturing effective policy and regulation of the power sector,' the report added. Promising a quick delivery from the NIPPs it stated: 'One of the projects, at Olorunsogo, now contributes 113MW to the national grid. New capacity of 690MW was expected by December 2011 and a total of additional 1,000MW, while 2,967MW are expected by December 2012 and December 2013 respectively. The NIPP (projects) are expected to have delivered a total of 4770 megawatts to generation capacity by December 2013,' On the IPPs, it expressed optimism that the contract awarded to the Independent Power Producers by the Bulk Trader would 'generate additional 6, 000 megawatts by 2014 of which almost 3,000MW will be available by 2013'. On the progress made so far in creating a private-sector-led power industry, the PTPF said investor confidence is growing, as 331 companies have expressed interest in investing in Nigeria's generation and distribution of power.

1.1 Conceptual elucidation

Energy Efficiency is producing the same level of energy services with less energy input. It is decreasing the use of energy per energy service without affecting the level and quality of these services. A thorough energy audit is to good energy management as a thorough financial audit is to good financial management.
So, energy auditing is an exercise aimed at:

- determining how, where and when energy is being used and /or wasted
- identifying opportunities to reduce energy usage
- formulating prioritized recommendations for implementing process of improvements to save it.

Energy efficiency and conservation
Energy efficiency and conservation is 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"
or "using energy more efficiently, whether through behavior, improved management or the introduction of new technology."

Sustainability
"Sustainability is improving the quality of human life while living within the carrying capacity of supporting eco-systems Sustainable development is define as a pattern of resource use that aims to meet human needs by preserving the environment so that these needs can be met not only in the present but also for future generations

Compact fluorescent lamp (CFL) bulb

A CFL bulb is a type of fluorescent bulb that screws into a standard light socket, such as a lamp or ceiling light fixture. CFLs use much less energy and last up to 10 times longer than standard light bulbs.

A CFL bulb is made of glass, a ceramic and metal base, a luminous powder called phosphor, and a small amount of mercury.

Compact fluorescent tube, is a fluorescent lamp designed to replace an incandescent lamp; some types fit into light fixtures formerly used for incandescent lamps. The lamps use a tube which is curved or folded to fit into the space of an incandescent bulb, and a compact electronic ballast in the base of the lamp. Compared to general-service incandescent lamps giving the same amount of visible light, CFLs use one-fifth to one-third the electric power, and last eight to fifteen times longer. A CFL has a higher purchase price than an incandescent lamp, but can save over five times its purchase price in electricity costs over the lamp's lifetime.

Incandescent lamp (IL)

A lamp that produces light by heating up a filament of wire inside a bulb with an electric current, causing incandescence. The glass bulb containing the filament is filled with a nonreactive gas, such as argon, to prevent the wire from burning. An electric lamp consisting of a transparent or translucent glass housing containing a wire filament (usually tungsten) that emits light when heated by electricity.

Light Emitting diode (LED)

*An **LED lamp** (or **LED light bulb**) is a solid-state lamp that uses light-emitting diodes (LEDs) as the source of light. LED lamps offer long service life and high energy efficiency, but initial costs are higher than those of fluorescent and incandescent lamps. Chemical decomposition of LED chips reduces luminous flux over life cycle as with conventional lamps. Unlike Cfl it does not contain Mercury which is very toxic to health and the environment*

Minimum light output (lumens)	Electrical power consumption (Watts)		
	Incandescent	Compact fluorescent	LED
450	40	9–13	4-5
800	60	13–15	6-8
1,100	75	18–25	9-13
1,600	100	23–30	16-20
2,600	150	30–52	25-28

Table 1. Electrical power equivalents for different lamps

1.2 Overview of energy crisis in Nigeria

Energy is an essential component of the modern society in that all production and manufacturing activities revolve around it. It is used in industry, agriculture, production, material processing, communications and likewise. It cannot be over-estimated how essential it is that energy supply is consistent especially in an increasingly industrious and business-centric country such as Nigeria. Nigeria happens to be a centre of a large energy reservoir, having the 10th largest oil reserve in the world. Crude oil has been the main source of energy as well as revenue in the country. The increased dependence has no doubt been of benefit at large to the country by providing employment, development of infrastructure, opportunities for strategic alliances between Nigeria and other countries and primary source of revenue to government of the country. In the same vein, it has led to unfortunate economic lapses due to its setback.

The process of refining crude oil is quite expensive and requires a lot of capital investment. It is often the case that resources for other sectors of the economy are digressed into the petroleum industry. Other countries are beginning to seek alternative sources of energy that are cheaper and more environmentally friendly. Beside the external effects, Nigeria in itself is affected by energy crisis arising from oil production. Conflicts are peculiar to areas where the crude oil exists. Lives and properties are being lost on a daily basis and the tension in the area makes the residents live in constant fear of attacks. With the amount of crude oil the country exports, between 2.2 - 2.5 million barrels a day, it is ideally expected that it should be able to provide energy for its citizens. However, the supply of electricity nationwide is lacking. On average, citizens in most regions receive only 6 hours supply of electricity daily at best. There are many rural areas in the country that are yet to even have access to any electrical power. They still rely on some other mechanical sources of energy like fuel wood. Fuel wood combustion results in emission of poisonous gaseous substances which are dangerous to man and his environment. This does nothing to detract from Nigeria's image of being one of the world's largest producers of carbon emissions, closely associated with global warming. Others, who can afford to, acquire privately owned generators which are barely cost-effective. Putting the above monster in mind, this survey was carried out as part of short term solution to this crisis in Nigeria.

Over the past decades, Nigeria population has increased to over 150Million, with an average GDP growth rate of 6.66% over the last 5year. Within this period, power generation capacity was stagnated. These factors combined with inadequate maintenance in existing power generation plants resulted in the short supply. In order to improve power supply considering its cursory effect on the economy,

informed the Federal government decision to deregulate the sector.

The Bureau of Public Enterprises and its supervisor, the National Council on Privatization, headed by the Vice-President, Namadi Sambo are charged to transparently deregulate the sector as our economic recovery is dependent on the successful transfer of power sector assets and their management from the kleptomaniac and inefficient public sector to private operators. According to the BPE, the 25 firms are bidding for stakes in four thermal and two hydro power companies. The six are part of the 18 firms – one transmission, six generating and 11 distributions – unbundled from the state-owned monopoly. The BPE timetable sets August 14 to 18th 2012 for the evaluation of technical bids, which will be approved by the NCP by September 11 2012. Deadline for shortlisted bidders for the GenCos to file their letters of credit is September 18 2012 while October 2nd 2012 is for the bidders for the DisCos. Financial bids will be open between September 25 and October 10 2012 while the preferred bidders for the 17 firms will be named "on or before October 23,"

The sudden momentum towards transferring the power sector into private hands has been welcomed by the business community and ordinary Nigerians who have suffered power shortages for four decades. But there is nothing in the records of the Federal Government to inspire full confidence in a beneficial outcome. Our record in privatizing state-owned companies has been dismal. Not only do vested interests in the government undervalue assets, they also discourage the most reputable global operators in key sectors from buying them. Many in the government and the National Assembly are desperate to hold on to state firms as they are ready sources of sleaze money through dubious contracts and yearly budgetary provisions. It is such monumental corruption that has prevented the sale of Nigerian Telecommunications Plc., Ajaokuta Steel, and the four moribund state-owned refineries; while most of those eventually unloaded are mired in controversy and corruption.

It would be tragic to follow this well-worn corrupt route in the power sector privatization. With national demand put at 12,000-15,000 megawatts, current power output is a meager 4,47700MW which is recently achieved. The organized private sector, which estimates that cost of providing alternative power has risen over the previous 40 per cent of total production costs, blames the power crisis largely for the shutdown of about 900 factories in 2010-2012 and worsening unemployment

2.0 Survey

Energy efficiency and conservation have been carried out by Energy Commission of Nigeria and other stake holders on both residential and industrial sections and its awareness campaigns taken to the nooks and crannies of Nigeria to achieve its intended purpose of freeing the wasted energy for sustainable growth. Based on the foregoing, a survey on energy efficiency measures was carried out in some selected estates in the FCT as pilot project.
The National efficient lighting programme, replacement of 1million of incandescent bulbs with CFL with the aim of finding a short term solution to the energy crises in Nigeria carried out by my team at ECN with the collaboration of Ecowas and Cuban government using the Cuban energy revolution experience.
The first phase was aimed at reducing 150MW.

Cuban Energy revolution
Cuban a country once faced with energy crisis, took a giant strip in achieving energy breakthrough. In 2006 cuba took a holistic approach to solve energy shortage through a five points plan viz;

- Energy efficiency and conservation
- Increasing the availability &reliability of electric national grid
- Incorporating more renewable energy technology
- Increasing the exploration & production of local oil & gas
- Engaging in international cooperation

The first step taken was to reduce demand of wasteful usage. Cuba's electricity utility has wasted no time in exploiting the "oil deposit" of conservation. According to Guevara-Stone, it mobilized consumers to replace more than 9 million incandescent light bulbs – almost 100% of the bulbs used in the country – with compact fluorescents within six months. Under the utility's program, more than 2 million energy-efficient refrigerators, 1 million fans, 182,000 air conditioners and 260,000 water pumps were sold. Cuba has promoted renewable energy for off-grid electrification for many years. In the meantime, 8000 solar electric systems have been installed to electrify all schools, health clinics and social centers in the country, and many residential buildings. Cuba is adding 300 biogas plants which are based on animal waste this year, and plans to electrify the remaining 100,000 houses that have no access to electricity with renewable energy. Cuba has won international recognition for its rural electrification programs for many years, for example by receiving the UN's Global 500 award in 2001. In April 2007, UNEP executive director Achim Steiner praised the country's energy revolution.

2.1 The result and analysis of replacing 1million IL with CFL in Nigeria.

After the pilot project which covers about 29 estates and some government institutions across Nigeria, the result obtained was used to make projected estimate of about 115million CFL needed to cover the entire Nigeria.

For developing Countries, like in the case of ECOWAS, where there should be an average of 5 bulbs per house, with a Wattage of 60 Watts, and a daily use light for 6 hours, with coincidence factor of O.6 bulbs functioning.

Coincidence factor is the percentage of the electrical connected load that is on at a particular time.

The effect of replacing 1million lamps is calculated thus

2.1.1 Calculation for Replacing 1million IL with CFL in Nigeria

Quantity of incandescent lamp = 1,000,000

Average wattage of IL = 60W, coincidence factor (C.F)= 0.6 bulbs functioning,

Average wattage of CFL = 14W.

- The Electrical demand of 1M bulb (E1) = Quantity x Wattage x C.F
  =1000000 x 60 x 0.6 =36 MW
- The Electrical demand of substituting CFL (E2) = 1000000 x 14 x 0.6 = 8.4 MW
- Reduction in demand after substitution = E1-E2 = 36-8.4 = 27.6MW

Nigeria will not have to build a new generating plant with savings of = $27,600,000

- Reduction in monthly electrical consumption = number of work hour x demand reduction x days in a month = 6h x 27.6 MW x 30 = 4968MW.h
- Reduction in Annual electrical consumption =6h x 27.6MW x 365 =59616MW.h

1 Tons = 3.511MW

- Therefore Tons of fuel saved monthly = $\frac{4968}{3.511} =$ 1415 ton
- Tons of fuel saved annually = $\frac{59.616}{3.511} =$ 16980 ton

1 ton of fuel = $750

* Monthly monetary savings = 1415 x 750 = $1061250

* Annual monetary savings = 16980 x 750 = $ 12735000

* Cost of each bulb CFL Lagos = $ 1.61

* Cost of 1 Million CFL = $1610,000

* Investment recuperation time (Payback time) = $\frac{Cost\ of\ CFL}{Monthly\ Monitoring\ saving} = \frac{1610,000}{1061,250} =$

1.5 $month$

* By the end of the first year Nigeria would have saved just from fuel = Annual savings – Cost of CFL = $ 12735000 - $1610000 = $ 11,125,000

2.1.2 Result

We arrived at the following results:

1 They will substitute - - - - - - - - - - - - - - - - - 1’000,000 Bulbs

2 The Electrical Demand of one Million bulbs - -------- 36 MW

3 The Electrical Demand after the substitution--------- 8.4MW

4 Reduction in Demand after the substitution - ------- 27.6 MW

5 They would not have to build new---------- 27.6 MW

6 Generating Plants with Savings of - - - - - - - - ------ $27’600,000

7 Reduction in Monthly Electrical Consumption---------4,968 MW.h

8 Reduction in annual Electrical Consumption---------59,616 MW.h

9 Tons of fuel Savings monthly - - - - - - - - ---- -------- - 1,415 Ton

10 Tons of fuel Savings annually - - - - - - - - - ---------- 16,980 Ton

11 Monthly monetary Savings - - - - - - - - - - -------- - ----$1'016,250

12 Annual monetary Savings - - - - - - - - - - - ---------- - $12'735,000

13 Cost of each bulb CFL Lagos - - - - - - - - ---------- ---$1.61

14 Cost of the one million - - - - - - - - - - - - - -------- ---- -$1'610,000

15 Investment recuperation time - - - - - - - ---------- ---- 1. 5 Months

16 By the end of the first year Nigeria would have- Saved just from fuel--$11'125,000

2.2 The result and analysis of replacing 115 Million IL with CFL estimated to cover the whole Nigeria.

Putting the parameters for estimating developing countries like Nigeria into consideration, where there should be an average of 5 bulbs per house, with a Wattage of 60 Watts, and a daily use light for 6 hours, with coincidence factor of O.6 bulbs functioning.

The effect of substituting 115million IL bulbs with CFL is got from the calculations

2.2.1 Calculations

Quantity of incandescent lamp = 115000000

Average wattage of IL = 600w, Average wattage of CFL = 14w, CF=0.6

* The electrical demand of 115m bulbs (E1) 1L = Quantity x Wattage x C.F

=

115000000 x 60 x 0.6 = 4,140

* The electrical demand after substitution (E2) CFL = 115000000 x 14 x 0.6 = 966 MW

* The reduction in demand after substitution = 3,174MW

* Nigeria would not have to build new generality plants with saving 0.6 = $3,174,000,000

* Reduction in monthly electrical consumption = No of Hours Worked x Demand reduction x No of days = 6h x 3174 x 30 = 571320mw.h

* Reduction in annual electrical consumption = 6h x 3174 x 365 = 6855840mw.h

1 ton = 3.511mw.h

Therefore tons of fuel saved monthly = $\frac{571320}{3.511} = 162723\ tons$

Therefore tons of fuel saved annually = $\frac{6855640}{3.511} = 1952674\ tons$

1 ton of fuel = $750

* Monthly monetary savings = 162723 x 750 = $122042250

* Annual monetary savings = 1952674 x 750 = $1464505800

* Cost of each bulb CFL in Lagos = $1.61

Cost of 115 Million bulbs = $1.61 x 115 = $1855150000

Investment recuperation time = = $\frac{cost\ of\ CFL}{monetary\ savings} = \frac{185150000}{122042250} = 1.5\ months$

* By the end of the year Nigeria would have saved from fuel

Annual Savings – Cost of CFL = $1464505800 - $185150000 = $1279355800

2.2.2 Projected Result

1. They will substitute - 115'000,000 Bulbs

2. The Electrical Demand of 115 million bulbs - - 4,140 MW

3. The Electrical Demand after the substitution - - - 966 MW

4. The Reduction in Demand after the substitution--- 3,174 MW

5. They would not have to build new----------3,174 MW

6. Generating Plants with Savings of - - - - - - - - - - - $3,174'000,000

7. Reduction in monthly Electrical Consumption - --- 571,320 MW.h

8. Reduction in annual Electrical Consumption - - - -- 6'855,840 MW.h

9. Tons of fuel Savings monthly - - - - - - - - - - - - - --- 162,723 Tons

11.Tons of fuel Savings annually - - - - - - - - - - - - - --- 1'952,672 Tons

12. Monthly monetary Savings - - - - - - - - - - - - - - - $122'042,250 USD

13. Annual monetary Savings - - - - - - - - - - - - - - -- $1,464'505,800

14 .Cost of each bulb CIF Lagos - - - - - - - - - - - - - - --- $1.61 USD

15. Cost of the 321,172 bulbs - - - - - - - - - - - - - ---- -- $185'150,000 USD

16. Investment recuperation time - - - - - - - - --------- 1, 5 Months

17. By the end of the 1st yr Nigeria would have Saved from fuel -- $1,279'355,800

3.0 Discussion

It is evidence in the survey result as well as the projection how energy efficiency will contribute to the overall sustainable development of Nigeria. The replacement of one million incandescent lamps with compact fluorescent lamps will have a resultant reduction on annual electrical consumption of about 56,616MW.h with the saving of 16,980tons of fuel of monetary value $11,125,000USD.

When 115millions conventional bulbs are replaced with energy efficient CFL estimated to cover Nigeria, about 6855840MW.h of electricity consumed annually will be freed for other developmental sector saving 1952674tons of fuel with monetary value of $1'279,355,800USD. In both survey, the return on investment (payback time) is 1.5 month respectively.

4.0 Challenges of energy efficiency and conservation in Nigeria

- Lack of political will in the creation of the enabling legislative and policy framework for the implementation of EEC measure in the country.
- Lack of Introduction of incentive and disincentive packages that encourages the penetration of energy efficient products and discourages the inefficient ones.
- Inadequate required human capacity need for the implementation of energy efficiency and conservation measure.
- Inadequate national sensitization and awareness creation on energy efficiency and conservation
- Energy saving barriers experienced in most residential settings include:
  - Lack of awareness by residents
  - Poor maintenance of appliances
  - Unconcerned attitude to energy facilities
- Poor system of billing and payment collection from the customers particularly residential

5.0 Recommendation

- Intensification of the nationwide sensitization and awareness creation programmes on the

benefits of energy efficiency and conservation.

- Creation and enforcement of enabling institutional and legislative framework for implementing energy efficiency and conservation Programmes.
- Full and transparent deregulation of the sector
- Energy Legislation: passage of the National Energy Policy and the National Energy Master Plan into law by the act of National Assembly.
- Capacity building in the training of Energy experts (energy auditors, energy managers).
- Effective collaboration of all the government agencies that has a stake in energy efficiency and conservation.
- Establishment of energy efficiency and conservation and Renewable Energy equipment /devices manufacturing plants in the country
- Proper energy tariff , billing and payment collection systems
- Enforcement of prepaid electric power meter on all categories of consumers
- Mandatory energy audit for all larger energy consumers

6.0 Conclusion

Power supply is pivotal to the achievement of vision 20:2020. The current electricity demand which stood between 12,000MW and 15000MW in Nigeria with just a supply output of 4477MW is worrisome. With the measures put in place to boost the sector, which include deregulation to attract investors, extra effort is needed to be put in place to improve the supply since about 26,561MW is estimated to meet demand by the year 2020 if the millennium development goal is to be achieved.

Therefore, the need to pursue energy efficiency and conservation vigorous is imperative. The promotion of renewable energy mix technology such as the exploitation of Solar, wind, biomass, Small hydro and nuclear energy will contribute in no small measure towards a cleaner energy supply as they are environmentally friendly and reduce the incidence of climate change. Thus, urgent steps must be taken by the government and the citizens in holistic pursuit of energy efficiency and conservation to achieve a sustainable economic growth of Nigeria.

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