CHALLENGES AND PROSPECTS OF ENERGY EFFICIENCY AND CONSERVATION

Adegbenro, O.
National Centre for Energy Efficiency and Conservation, Faculty of Engineering,
University of Lagos, Lagos. Nigeria

ABSTRACT

A critical look into the challenges of energy efficiency and conservation in Nigeria and how these can be addressed is brought into focus in this paper. Power generation and distribution in Nigeria is still a major stumbling block to economic development, coupled with the fact that the fossil fuel sources needed for generation of power are dwindling. To address this, renewable sources need to be explored and exploited. Proper management, via energy efficiency and conservation, of these resources would help meet future demands and create a cleaner environment for all.

Energy theft, poor billing schemes, ignorance, higher cost of energy-efficient alternatives among others, are some of the impediments in putting energy efficiency and conservation into practice. The Government is, however, taking steps to overcome these challenges by creating research centers to tackle these issues. However, more still needs to be done in policy implementation to make energy efficiency and conservation a reality.

Keywords: Efficiency; conservation; challenges;

1.0 INTRODUCTION

In recent times, world debate on energy issues is predicated on the availability of sustainable and affordable energy supply. As the evidence of climate change and dwindling fossil fuel reserves become a reality, most world leaders are searching for ways to ensure that their economies are not stagnated in the face of these challenges – Nigeria is no exception.

Currently, Nigeria is a net exporter of energy (mostly in the form of crude oil) from which it earns the largest percentage (about 91%) of its foreign exchange. The fact that energy demand is expected to increase has raised questions concerning the net availability of this form of energy in the future. For instance, Nigeria's energy demand increased from 4.2×1.0^{14} BTU in 1980 to 1.13×10^{15} BTU in 2004. This increase in demand is expected to continue as the country becomes more industrialised, and as the standard of living and population increases. It is also important to note that to meet the current and future demand in a sustainable manner, other primary energy sources will have to be explored and exploited.

Exploiting renewable energy sources like wind, solar and thermal, is one way of meeting energy demands in a sustainable manner. However, there exists another 'energy resource' which is clean, not intermittent and does not compete with food crops. This 'energy resource' is referred to as Energy Efficiency. This term is associated with using less energy to achieve the same amount of work. Given that 'money saved is money earned', it is considered as an energy resource because energy saved can be available for other productive uses. Though currently not very popular in this part of the world, it is believed that energy saved through efficiency will help meet future demands, reduce the need for more power plants and reduce pollution generally. This would encourage stakeholders to invest more in research of energy efficient materials among other things. Nigeria must systematically align itself to this recent trend and must be able to adopt these technologies that ensure energy efficiency, as they become available.

In what follows, the challenges faced by Nigeria in achieving energy efficiency and conservation are discussed in detail.

2.0 CHALLENGES AND PROSPECTS

The challenge facing energy efficiency and conservation encompasses the use of energy inefficient products, behavioural problems and dependence on energy sources whose exploitation are harmful and leads to environmental degradation.
Electrical energy, being the most widely available generic form in which energy is utilized, is the focus of this paper. Therefore the challenges and prospect for energy efficiency is discussed below in terms of electrical energy.

2.1 BEHAVIOURAL PROBLEMS

The behaviour of individuals with respect to energy consumption presents a major problem to the implementation of energy efficiency in Nigeria. These problems include energy theft, poor billing and ignorance.

2.1.1 Energy Theft

Electricity supply in Nigeria is currently not adequate for the citizens' needs. This limited supply has the attendant effect of people struggling to get electrical power by all means necessary. Some individuals resort to making illegal connections to power lines (commonly known as tapping) or bribing power authority officials to give lower bills than what they actually consumed or to supply power to them instead of others in cases of load shedding. Dangers associated with energy theft include fires, electrocution, death, etc to the perpetrator and also to innocent people.

A way of curbing this theft is via the use of electronic card meter systems, in place of the older electromechanical ones. In advanced countries, the use of smart metering systems helps reduce electrical load, and also monitor deviations from expected usage, or any other anomaly. Since these meters can be accessed remotely, any anomaly or tampering that is detected would trigger alarms at the supplier's end. Energy theft makes energy efficiency and conservation practices difficult as there are no proper records of energy usage and those who consume energy efficiently cannot be acknowledged. Also, it makes network planning and optimisation difficult.

2.1.2 Poor Billing Scheme

Some consumers of electricity in the country are given estimated bills. In other words, the amount of money they pay for electrical energy is not commensurate with the amount of energy they consume. For instance, whether a consumer uses 500kWh or 10,000kWh of energy for a particular period of time, he would be billed the same amount of energy. Therefore, such consumers would see no need to implement conservation techniques. The most effective way of encouraging the practice of conservation techniques is to show consumers the gains they can reap, and estimated billing system would stand as an obstacle to this. To solve the problem associated with poor billing, more efforts should be put into the implementation of the pre-paid system of billing. This would ensure that consumers see the effect of conservation measures they observe, such as switching off appliances or buying energy efficient appliances and would act as a stimulant for the propagation of energy efficient and conservation habits.

2.1.3 Ignorance

There is generally a low level of awareness on ways of conserving energy. Several people that the NCEEC interacted with while creating awareness on the need for energy efficiency and conservation consider it to be a new idea and confessed to the fact that they leave appliances and lights on without thinking of the consequences. Below is a summary of comments at an awareness session NCEEC undertook recently.

From fig 1, it can be seen that a large percentage of respondents encouraged energy efficiency and conservation programmes. Thus, mass enlightenment campaigns via fliers, radio jingles, stickers, posters, etc, should be carried out to educate the people. Stickers and posters bearing information or tips on how people can

conserve energy at home, offices and industries are presently being distributed; however, a lot still remains to be done to increase the awareness level.

2.2 USE OF ENERGY INEFFICIENT APPLIANCES

There are several electrical appliances common to the industrial, commercial and domestic sector of any society. These include lighting systems and HVAC (heating, ventilation and air-conditioning) systems. Other electrical devices are industrial components like electric motors, boilers, compressors, etc.

2.2.1 Lighting Systems

Most homes and industries in the country still use incandescent and halogen lamps which generate light and heat are consequently inefficient. However, there are energy-saving lamps such as compact fluorescent lamps (CFLs) and light emitting diode (LED) lamps that consume less energy and provide better illumination. For example, a 14 watt CFL is as bright as a 75 watt incandescent lamp. Consequently, the energy wasted in industrial, commercial and domestic lighting would be greatly reduced. To further illustrate this point, NCEEC replaced a total of 442 incandescent bulbs with CFLs of appropriate luminance at the University of Lagos Guest House (see Tables 1 and 2 below). This exercise resulted in the reduction of lighting loads from 25.92KW to 4.29KW. This represents approximately 83% reduction in lighting energy bill.

HVAC systems are among the highest energy consumers in both the domestic and industrial sectors and thus present great opportunity for savings. The challenge posed by HVAC systems is basically due to the energy needed to operate electric motors or compressors powering its centrifugal pumps and fans. To address this problem, it should be noted that for HVAC systems to operate efficiently, it must meet optimum heating and cooling needs which vary according to the time of the day and the season. In this case, variable air volume systems with variable speed drives would play a major role. These regulate the power used by the electric motors or compressors and consequently the speed of centrifugal pumps and fans, ensuring that the HVAC systems do not run on full power all the time but use only the power needed at a particular time. This would reduce the energy used by HVAC systems significantly. Besides this reduction in energy, comfort level of a building would be increased significantly since it would neither be overheated nor overcooled.

2.2.3 Other Electrical Appliances

The use of other electrical devices poses a problem to energy efficiency and conservation in Nigeria. For example, some consumers still use the Cathode Ray Tube (CRT) television sets and computer monitors. These CRT television and monitors consume an enormous amount of energy compared to their Liquid Crystal Display (LCD) counterparts. Also, older fridges and freezers, use more energy than newer models. Switching off appliances and unplugging completely rather than putting them on standby, replacing worn out fridge and freezer seals, and regular cleaning and maintenance of these appliances are some ways of conserving energy.

2.3 ELECTRIC MOTORS, COMPRESSORS AND BOILERS IN INDUSTRIES

Most industries in Nigeria make use of electric motors, compressors and boilers which are enormous energy consumers and constitute a great percentage of energy consumed by the industries. Consequently, there is great potential for savings in industries given the efficient use of these electrical devices.

2.3.1 Electric Motors

Electric motors are prime movers in the manufacturing industries. They consume the highest amount of energy compared with other industrial energy consuming devices. Certain components of motors degrade with time and operating stress and contact between moving surfaces causes wear. Wearing of motor parts is exacerbated by dirt, moisture, and corrosive fumes, and when lubricants are misapplied these parts become overheated. Electrical

insulation also weakens over time with exposure to voltage unbalance and temperature. Measures of reducing the power consumed by these motors include some of the methods discussed below.

2.3.1.1 Power factor correction

A large percentage of the electric motors used in the industry are of the 3-phase induction motor type. They are very rugged, simple by design and operation and run at a fixed speed. In operation they draw real and reactive powers, the latter contributing to the increase in energy consumption. The electricity service provider (PHCN) bills the company higher for drawing reactive power at a lower power factor. This has continued to pose a challenge to the energy demand and stability.

Installation of capacitor-banks in parallel with the load to reduce reactive power consumption will lower the energy drawn by these motors[1]. From a recent industrial visit to a five-star hotel in Lagos, it was found that the installation of three (3) 125KVAr banks of capacitors increased the average power factor of the electric motor systems from 0.80 to 0.99. This translates to roughly 25% reduction in the cost of electrical energy.

The same consideration applies to the wide spread use of CFL which is being vigorously advocated. This will increase the demand for reactive power that is bound to affect the ability of the power provider to deliver power. The implication is that power delivery will either be more expensive or the consumer will have to pay more for a CFL that has integrated PFC.

2.3.1.2 Heating of motors

It is known that a higher operating temperature shortens motor life. According to the U.S Department of Energy, for every 10°C rise in operating temperature, the electrical insulator life is cut in half. This reduction in insulation would lead to losses in form of heat which is power wastage. Eventually the insulation breaks down and the electrical windings burn up and the motor is destroyed. To reduce these loses regular maintenance of the cooling fans of electric motors should be carried out and the ambient operating conditions be, as much as possible, as specified by the manufacturer.

2.3.2 Boilers

Regular boiler inspection is important for their optimal function, life span and energy efficiency. As boilers are high energy users, inefficient operation means wasted energy and increased costs. Performance monitoring of boilers is imperative in process industries as the major portion of the operating cost is determined by the fuel consumed in the boilers due to the deposit soot or scales they produce [2]. There is a loss in evaporation capacity due to the accumulation of these soot/scales and is given by

$$\frac{1}{U} = A + B \times t$$

Where: U is the heat transfer coefficient in kcal/hr/m^2/°C

t is the time lapsed since last cleaning.

A ≥ Normal efficiency at full load

B ≥ Efficiency after time t

Maintenance activities should be carried out regularly in order to prevent degradation of equipment and minimize losses.

2.3.3 Compressors

For compressors to be more energy efficient, weekly or monthly maintenance should be carried out with a view to reducing compressed air leakages and maintaining an optimal air storage strategy to help balance supply with demand. These will improve and enhance the efficiency of the compressor and reduce its work load.

Also as motors generate a lot of heat, fans are pre-installed to reduce the temperature. These fans, with time, tend to use more energy to provide the same level of cooling. Regular maintenance of operational fans and repair of broken-down ones would reduce the energy consumption of the motors and improve motor reliability. They should also be located in well-

shaded and ventilated areas.

2.3.4 Transmission Efficiency

Transmission equipment including shafts, belts, chains, and gears should be properly installed and maintained. When possible, synchronous belts or chains should be used in place of V-belts. Helical gears which are more efficient than worm gears should be used with motors under 10 hp.

2.4 POLICIES AND REGULATION

2.4.1. Importation of Incandescent Bulbs and Inefficient appliances

Allowing importation and manufacture of incandescent bulbs and inefficient appliances will continue to increase the energy consumption in the country. Government should as a matter of urgency encourage the importers to bring in energy-efficient appliances and lamps into the country. This can be achieved by granting duty-free imports or tax rebates to these importers so as to discourage the importation of the inefficient appliances. As an example, some countries have come up with policies to promote the use of energy saving lights, via subsidies on energy-efficient lights and appliances and a clamp on production and importation of inefficient appliances.

2.4.2 Absence of tax rebate and subsidy on renewable energy systems

The cost of procuring renewable energy systems is relatively expensive. To reduce the cost of renewable energy systems, government should give tax rebates to manufacturers and marketers of these systems. Also, government subsidies would encourage the purchase and use of renewable energy technology. It is therefore imperative for the government to incentivise the adoption of renewable energy alternatives.

2.4.3 Monopoly

The challenge of having an establishment without competitors in its line of business, as it has been found from the Nigerian experience, is that monopolies encourage bureaucratic corruption, nepotism, bureaucratic bottle-necks, buck passing and poor service delivery. An example can be found in the Telecommunications sector where competitors within and outside Nigeria where granted operational licenses. The success story of the telecommunications sector in Nigeria shows that if government creates an enabling environment for private sector participation it would yield tremendous benefits. Else, expected investors in the industry would not be forthcoming and the benefits of privatization would not be realised in the near future[3].

Therefore, the onus is on government to break the monopoly of the electrical sector and create an enabling environment were venture capitalists can explore the associated risks and return on investments on electrical generation, distribution and service delivery.

3.0 CONCLUSION

Energy theft in the power sector, poor billing issues and ignorance are some of the challenges being faced in implementing energy efficiency and conservation and harnessing its benefits. The intervention of the government and active participation of the general public are crucial factors in overcoming these challenges.

Lighting systems, HVAC systems and electrical appliances are common areas that present great opportunities for energy savings in Nigeria's industrial, commercial and domestic sectors. Reasonable savings can be achieved with the use of CFLs in lighting, variable frequency drives in HVAC systems, implementation of power factor correction in motors, and regular maintenance of equipment. The Nigerian Government has taken important steps towards establishment of research centers to help formation of energy efficiency and conservation policies. However, policy implementation is the key to realizing the set objectives and Government should continue to strengthen these institutions.

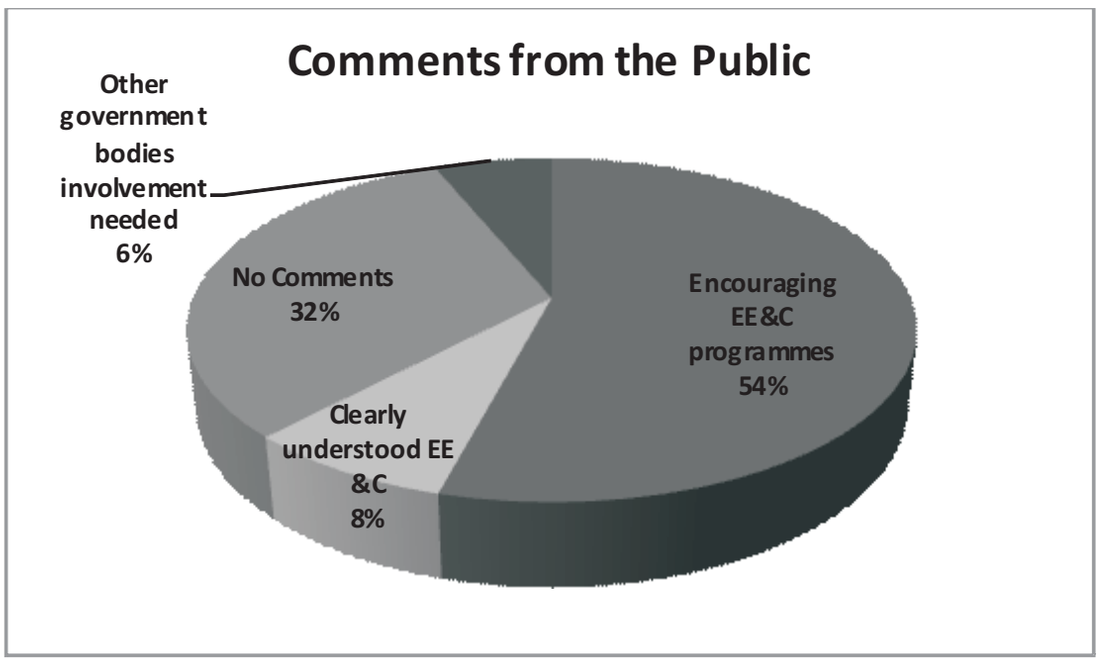

Fig 1: Comments from 240 members of the public

Table 1: Shows the total number of incandescent lamps at different locations

NO	LOCATION	QUANTITY	WATTAGE	TOTAL POWER
1	Corridor	84	60	5040
2	Staircase	30	60	1800
3	Restaurant	44	60	2640
4	Conference Halls	24	60	1440
5	Rooms and Toilets	260	60	15000
	TOTAL	442		**25,920**

Table 2: Showing the total number of Compact Fluorescent lamps replacing incandescent lamps at different locations

NO	LOCATION	QUANTITY	WATTAGE	TOTAL
1	Corridors	84	18	1512
2	Staircase	30	14	420
3	Restaurant	44	14	616
4	Conference Halls	24	11	264
5	Rooms	200	5	1000
6	Toilets	60	8	480
	TOTAL	442		**4,292**

BIBLIOGRAPHY

1. S. Rao, B. B. Parulekar. Energy Technology: Nonconventional, Renewable and Conventional, Khanna Publishers (2007)
2. G. G. Rajan. Optimizing Energy Efficiencies in Industry, McGraw-Hill (2003)
3. Chris C. Okoro. Energy Conversion Principles and Systems for Power Engineering, University of Lagos Press. (2010).