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Problem of Energy Sufficiency: A Case for Conservation

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Abstract *– Energy is herein discussed in the light of perceived solution to the energy sufficiency problems. With supply being the main focus and approach it is observed that demand often exceed capacity of local sources to cope. Wastage of energy is a common phenomenon with all energy converters, being a condition imposed on them by thermodynamic, molecular and structural constraints. Energy waste reduction and better management of available energy resources can be achieved by employing simple methods like substituting inefficient appliances with more efficient ones, reduced or complete stoppage of unnecessary use of some appliances by proper and better planning and designs of buildings to utilise natural illumination and air (wind).Planting of trees to provide shade from the Sun and provision of shading for external walls and windows to retard heat flow from outside are also suggested as ways of reducing energy load demands which will ultimately help solve the problems of energy sufficiency.*

Index Terms – **Energy converters, Energy resources, Energy sufficiency, Energy waste.**

I. INTRODUCTION

Modern man lives in an energy dependent society whose survival relies on the continuous supply. He utilises energy for almost everything, from normal body metabolism to industrial processes.

The story of the use of energy is more or less the story of civilisation or modernisation. From the discovery and control of fire to harnessing the power/energy of flowing water and wind, energy of draught animals and the use of coal, steam, oil, electricity, gas and nuclear energy, man has evolved from the prehistoric caveman hunter who consumes his food raw to the industrialised and technological man that utilises energy, produced outside his own body, to move about, process food, communicate, control his/the environment, recreate and entertain himself.He is the only animal capable of consuming more energy than he produces. Total energy consumed globally in 2010 was $5.53 \times 10^{11}\,GJ$ [1], equivalent to every individual riding more than 1000horses non-stop all day (with world population of 6.885 billion in in 2010 [2]. According to[3] in [4], an individual American uses about 93,000 kilowatt-hours (kWh) of energy, equivalent to 8000 litres of oil, for all purposes, including transportation, heating, and cooling every year.

Energy has the potential to provide comfort, transportation and ability to produce food and material goods, attributes that make itessential to our way of life.Its availability and proper use in a country, according to [5], can improve the economic life of the citizens.

It is no gainsaying that modern economics depend on energy for sustenance. The magnitude of energy consumed per capital is often used as an indicator of a country's development, with growth in energy consumption corresponding to growth in gross domestic product, and in turn development.Provision of sufficient quantities of energy is therefore perceived to be the central problem of energy availability.

With supply as the main (if not the only) focus in approaches to solving energy problems, demands often exceed the capacity of local and available sources to cope,so much that there is need to source for supplements from other nations. Reference[6] reports that the United States of America, Japan, the United Kingdom, France and Germany imported about 19%, 89%, 31%, 46% and 60%, respectively, of theenergy they consumed in 2011 9see fig 1).

Although there is a global race towards renewable energy, fuelled by the realisation that fossil fuels would not be sufficient to meet up with the increase [7], coupled with mounting global cry for reduction in CO_2 emission, which has led to massive research and investment into alternative renewable energy sources and systems,some countries even offering incentives to encourage deployment of renewable energy technology systems [8],many nations still source the bulk of their energy from fossil fuel sources. According to [9] only 4.1% of energy

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consumed in the UK in 2012 was obtained from renewablesources. This is partly due to the intermittent nature of many of the most viable renewable energy sources and schemes.

Sourcing energy form renewable sources is alsonot without environmental challenges and shortcomings.78 % of the European Union'sshare of total greenhouse gas emissions, with her massive investment in renewable energy schemes, is from energy consumption [10].

Land and water use, release of hazardous substances and life-time carbon dioxide emissions are paramount environmental issues with many renewable energy technologies [11].

The supply driven approach to energy problems does not take into consideration the grave impact conventional, and otherwise renewable energy production has on the environment: plants, animals and the landscape.

The ever increasing demand for energy is due to increase in use of labour saving devices, increase in population, industrialisation and so on, which hasledto increase in production and search for more sources and resources. With world energy consumption increasing at between 2.5% and 4.0% annually [12], [13], [14] opined that the current pattern of consumption cannot be sustained. According to[15], there exist, already, indications of severe consequences for the future in terms of resource depletion, energy degradation and fuel shortages.

II. ENERGY CONSUMPTION AND EFFICIENCY

A. Waste Energy production

An important aspect of energy cycle that is little consideredin the search for solutions to energy availability problems is consumption. Consumption of energy employs the use of energy converters, devices and appliances that simply convert energy from one form to another and in the process satisfy a need or requirement. For instance, an incandescent bulb converts energy from electrical form to electromagnetic or radiant form that is perceived as light and heat thereby satisfying the need for illumination.

Incandescent bulbs are primarily designed to produce light for illumination.This is the case with almost every energy converter.Each is designed for a specific purpose. An electric fan motor is designed to produce mechanical rotation necessary for moving air and a loudspeaker to cause vibrations in air that produce sound, and so on. Whatever else is produced during the process is undesirable and therefore a waste, just like thepaper trimmings from the production of a book or pamphlet. The by-product from the conversion done by an incandescent bulb is heat. This constitutes a waste and is produced by every energy converter.

Production of 'wastes' is a phenomenon imposed on machines and equipment by thermodynamic, molecular and structural constraints. The coils of an electric motor will always warm up because of the resistance of copper, a factor necessary for inducing magnetic force needed for moving the armature and producing rotation of the shaft. Production of heat (warming up) is common to all appliances. For the shaft to rotate some energy is used up (wasted) to overcome friction in the bearings and so on.

B. Energy Efficiency

The effectiveness of an appliance to convert a given quantity energy (or at a given rate) from available form to another for a given purpose is given by its efficiency. This is defined as the ratio of useful energy output to total energy input. A tungsten filament (incandescent) bulb has an efficiency of 10%, and converts one tenth of input energy to light (useful output) and the remaining to heat, which is released to the surrounding. This implies that using incandescent bulbs for illumination amounts to wasting nine times more energy for every illumination produced.A gas/kerosene cooker, though designed to produce heat, radiates 35% of the fuel energy into the surrounding so that only 65% is used for actual cooking. Relative efficiencies of some household appliances are given in table 1. It can be seen that electric Iron with about the highest efficiency (98%) still wastes 2% of energy.

What this portends is that meeting or satisfying increasing energy demands by merely increasing energy supply increases energy waste production. Reducing waste production, or saving energy, implies better utilisation of available energy and a step toward energy sufficiency. According to [10] "energy saving is the quickest, most

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effective and most cost-effective manner for reducing greenhouse gas emissions, as well as improving air quality".

III. ENERGY CONSERVATION METHODS

A. Lighting

As pointed out by [15] the current high standard of living is due to energy utilization, the pattern of which must change in the light of dwindling energy supplies. Having lights on during the day was once considered ugly in the United Kingdom in the late 19th century. It indeed is a wasteful practice that should be avoided. Lights should be switched off when not needed, for example, when nobody is in a room or during the day.

Over illumination should be discouraged because excess lighting (with incandescent bulbs) produces excess heat, which adds extra load on the air conditioning system. Lower light intensities should be used in rooms by using lower wattage bulbs or fluorescent bulbs. Fluorescent are greatly improved with colour rendition comparable to incandescent and the ballasts eliminate perceptive flickers. They use about 35% less energy, are about three times as efficient, average efficiency is about 28% [16]. They produce about three times more illumination per wattand the average life is 10 times longer than that of incandescent bulbs. Substitution of one compact fluorescent bulb for an incandescent bulb will save a barrel of oil, keep 907.18kg of carbon dioxide (global warming) and 9.07kg of sulphur oxide (acid rain) from the atmosphere.

Building design should be such that there are no hidden areas and rooms that do not permit use of daylight illumination. The quality and ambiance of natural lighting are unsurpassed and it is free. Lighting design for buildings should be based on standards of reduced general lighting with highlighting for specific functional considerations.Reference [17] opined that using light-coloured carpets and tiles, and painting walls with bright and reflective colours can increase inter-reflectance and improve both natural and artificial illumination.

B. Cooking

Using electricity for water heating increases energy wastages as about 35% of fuel energy would have been wasted (in the case of thermal generating plants) to produce electricity and, as noted by[14], 40% of the electricity produced is lost in the transmission lines. Gas/Kerosene stoves could be used for water heating instead of the normal practice of using electric heaters and kettles.

The use of pressure cookers greatly reduces the time and energy expended on cooking, saving between 50 to 75% of energy. Foods could be cooked in large quantities, stored away and warmed up in small quantities as and at when required, as a way of reducing energy expenditure on cooking. Matching pots with burner (with regards to size) also reduces wastages.

C. Electronics and Electrical Appliances

Electronics and electrical appliances have relatively high efficiencies. Energy saving in this area requires that they be switched off unplugged at the mains when not in use because they consume as much as 10J every second, each, on standby.

D. Refrigeration and Air conditioning

Refrigerators are essential, very efficient and cost effective. The efficiency can be further improved upon by ensuring that the condenser coils are clean and free of dust. This enhances heat exchange to the surrounding.

Air conditioners are also good and cost effective, but unnecessary in many cases of domestic use, especially for space cooling. Awareness of the cooling sense of moving air and the connection to the natural resource can enhance the user comfort. Breezes, the sound of birds and the smell of flowers are fundamental to the perception of air. This can be achieved with the use of ceiling fans, which consume far less energy. Having a wide gap or difference between indoor and outdoor temperatures is not good on the point of health, since temperature is not as important as the changes experienced when entering or leaving a room or building.

By providing external and internal shading for sun facing walls and windows and finishing walls with light colours, solar heat gains and cooling requirements can be greatly reduced[17]. Solar heat gains can also be

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reduced by adding insulation on the inside walls to retard heat flow from outside, and by planting trees around houses or buildings to provide shade from direct heat ofthe Sun.

E. Voltage stabilizers

Power supply from the electricity company in Nigeria is grossly inadequate. Out of the approximately 6538.3MW of installed capacity "not more than 4500 MW is ever produced" [18], and a substantial amount of this is lost in transmission[14], [19].Reference [20] observed that the nation has been suffering from chronicpower outages that result in low voltages, voltage fluctuations, power offs and load shedding. Fallout of this is the use of voltage stabilizers to safeguard appliances.

Average efficiency of voltage stabilizers range from95% to 98%, which means they waste between 2 – 5% of the maximum load. So a 1.5 kVA stabilizer connected to a 1kVA appliance would consume about 50 Watts.
Use of stabilizers could be avoided by replacing appliances that have small operating voltage range with one with bigger voltage range. They should also be switched off when connected appliances are off as they continue to consume energy when there is no load.

IV. CONCLUSION

World energy consumption is on the increase, implying increase in demand. This is not strange since world population is also on the increase.Underdeveloped countries are becoming industrialised, rural settlements becoming urban, and individuals' tastes are changing, so that more energy intensive, labour saving goods and appliances are being acquired. Meeting or satisfying this ever increasing energy needs does not, and should not, depend solely on increasing supply.

World per capital energy consumption was 65.9 x 10^6 Btu (6.953 x 10^4MJ), 64.3 x 10^6 Btu (6.784 x 10^4MJ),65.6 x 10^6 Btu (6.889 x 10^4MJ) and 71.8x 10^6 Btu (7.575 x 10^4MJ)in 1990, 1995, 2000 and 2005 respectively [13]. 2005 figures amounts to each individual having about 90 men work continuously all day doing heavy industrial-type work[21].The sad truth is the only a portion of this energy is actually consumed while the rest is wasted, and in most cases the largest portion is wasted.

Conservation or more efficient use and management of energy employing simple methods as discussed herein will go a long way to solving some of the energy problem and help to make energy more available and sufficient.

Government, on its part, can put in place policies and measures that encourage and promote energy efficiency and conservation.

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APPENDIX

Appliance	Ave. Efficiency (%)
Fluorescent Lamp	20
Incandescent (Tungsten) lamp	10
Electric Heater	85
Electric Iron	98
Ceiling Fan	92
Gas Cooker	65

Table 1.Average efficiencies of some household appliances (Source - The Open University, 1972)

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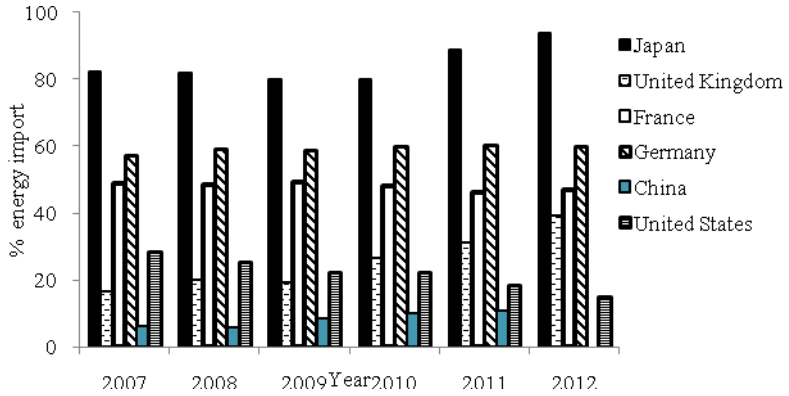

Fig 1: Energy impot by country (culled from [6])