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Combating Climate Change: The Role of Renewable Energy and Energy Efficiency

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Abstract

Climate change and its possible impacts on the environment and socio-economic systems now constitute the most important environmental problem facing mankind in the 21st century. Climate change will increase poverty and hardship, endanger food security, destabilize economies, decrease food and water and create social insecurity in many countries and undermine our goals for achieving sustainable development. An in-depth analysis was carried out on the nature and characteristics of climatic changes and the roles of renewable energy and energy efficiency in combating the threat of climate change especially in relation to mitigation measures. Energy policy is therefore becoming an increasingly important tool for medium and long term planning to mitigate GHG emissions and to adapt to climate change especially in the developing countries. This paper highlights the fact that research efforts for the rest of the 21st century be directed towards harnessing renewable energies like the solar, wind and geothermal energies to replace the present day burning of fossil fuel energy for lighting, heating, cooling, manufacturing, cooking, transport, entertainment, etc. This will help to reduce the emission of green house gases (GHGs) and ozone depletion and in the long run the global warming effect.

Keywords: *Climate change, socio-economic systems, energy efficiency*

1. Introduction

Climate is the synthesis of weather over a period long enough to establish statistical properties such as mean values, variance and probability of extreme events. The climate of an area is represented by the collective statistical data of the weather conditions during a specified period of time usually several decades. For example, we can say that the climate of Nigeria is characterized by the dry and the rainy season, since for several decades this has been the trend in Nigeria. The climatic system is complex and it is controlled by some permanent features of the earth: the atmosphere, oceans, cryosphere and land. The interactions between these features determine the climatic conditions in different part of the globe.

Climate change therefore can be defined as the variation in climate over a period of time ranging from a few years to decades. It can also be defined as the permanent departure of climate patterns from mean values of observed climate indices [1]. When rainfall amount or timing in any particular month, season or year deviates from what has been normally observed, the departures are noted. The observed variation, if noted from year to year, is an example of climate variability.

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When the departure persists, it is technically referred to as climate fluctuation. If the fluctuation persists for a sufficiently long time and is further found to be statistically significant, then this indicates that climate change has occurred.

Over the years owing to natural phenomena like earthquake, volcanic activities, cyclones, tornadoes etc. and human activities leading to the emission of green house gases, depletion of ozone layer, formation of acid rains etc, there has been a tremendous change in the climatic conditions and all have contributed to global warming which is one of the greatest threats now facing the planet earth. The present paper examines the various factors that lead to climate change, the impact of the change particularly as it affects developing countries and the possible role, the technological development and harnessing of renewable energy can play in improving energy efficiency and reducing the emissions that contribute to climate change.

2. Climate Change

Climate change is mainly caused by human activities. Human activities, both agricultural and industrial lead to the emission of increasing quantities of polyatomic molecules into the atmosphere. These polyatomic molecules are heat-trapping gases and are also known as greenhouse gases (GHGs). The

greenhouse gases include carbon dioxide (CO₂), chlorofluorocarbons (CFCs), methane (CH₄), aldehydes, nitrous oxides (NO)_x, ozone (O₃), water vapour (H₂O) and others. CFCs not only contribute to global warming, but also deplete the ozone layer exposing humans to skin cancer and eye disease and disturb the equilibrium of the ecosystem. These greenhouse gases cause the greenhouse effect, which is the reduction of the amount of infrared radiation emitted by the earth surface which escapes to outer space by these gases.

The GHGs have the tendency of absorbing infrared radiation thereby contributing to the greenhouse effect of the atmosphere. By greenhouse effect, the gases prevent the infrared radiation emitted by the earth from escaping to outer space. The greenhouse effect leads to the warming of the lower atmosphere and the earth surface. The primary greenhouse gases are CO₂ and water vapour, and they play a crucial role in regulating the temperature of the earth and the earth's atmosphere. Thus climate change is marked by global warming which is the increase in average surface temperature of the earth. Climate change has the potential to affect all natural and human systems, and poses a threat to human development and survival.

3. Greenhouse Gases Emission

The Intergovernmental Panel on Climate Change (IPCC), a body set up in 1988 by the World Meteorological Organization (WMO) and the United Nations Environmental Program (UNEP) to provide authoritative information about climate change phenomenon, asserts that the warming of the last 100 years was unusual and unlikely to be natural in origin. The IPCC has attributed the warming of at least the second half of the century to an increase in the emission of greenhouse gases into the atmosphere. Human activity is largely responsible for the emission of these gases into the atmosphere: CO₂ is produced by the burning of fossil fuels (coal, oil and gas) as well as land-use activities such as deforestation; methane is produced by cattle, rice agriculture, fossil fuel use and landfills; and nitrous oxide is produced by the chemical industry, cattle feed lots and agricultural soils. As humans have increased their levels of production and consumption, greenhouse gas emissions have also increased; since 1750 (the beginning of the Industrial Revolution) CO₂ emission has increased by 31 %, methane by 151 % and nitrous oxide by 17%. Moreover, the emissions of these gases continue to rise steadily.

CO₂ accounts for over 80% of the pollution leading to global warming and statistics reveal that collectively, industrialized countries are its largest emitters. The industrialized countries produce 25 times more CO₂ per head of population than the developing countries. The Hadley Centre for Climate Prediction

and Research shows that in 1996, the United States produced 5,300,990 metric tonnes of CO₂, the United Kingdom produced 556,983 metric tonnes, while Pakistan produced 94,333 metric tonnes and Bangladesh 22,959 metric tonnes. The disparity is also revealed by the fact that approximately 20% of the world's population lives in industrialized nations, yet they consume almost 80% of global energy.

The five largest emitters of CO₂ per capita are the USA, the UK, Japan, Germany and Canada, with the USA alone emitting one-quarter of the global greenhouse gas emissions. In reality, the USA with a population of about 300 million produces as much CO₂ as 135 developing countries with a combined population of 3 billion. As for Latin America and Africa, their contribution to global warming is very small when compared with that of the USA and the UK. The whole of Latin America contributes only around 4% of global emissions, equal to the amount produced by the UK while the entire continent of Africa contributes 3.5%. India is home to 17% of the world's population yet it only emits 4.2% of global greenhouse gases [2].

4. Impacts of Climate Change

Assessments by the IPCC revealed that the impact of climate change is largely on the poor. Disasters such as floods and droughts have already killed and affected millions, and these are predicted to escalate in frequency and intensity. Other effects of climate change include food insecurity, ill health, loss of forests and biodiversity, social and political instability and economic decline, all of which will be hardest on the poor. Climate change, therefore, is one of the greatest threats facing the poor.

Drought

When climate become warmer, it will cause widespread changes in the natural ecosystem. Droughts are now common across Africa and have affected the Sahel, the Horn of Africa and Southern Africa, particularly since the 1960s. Forest areas will shrink and grasslands and deserts will expand. Globally, dry lands areas are found in about 110 countries, covering 43% of the earth's land surface (i.e. 900 million hectares). About 20% of the world's population lives in the dry land areas. In Africa, dry lands cover 1959 million hectares in 25 countries of the continent which makes up 65% of the continent and one-third of the world's dry land. Climate change will worsen the trend and bring more hardship especially through severe drought [3].

The well known great droughts of the 20th century, that is the American 'dust bowl' of the 1930s and the Sahelian drought of the 1970 to 1980s were caused by temperature conditions of surface waters of neighboring oceans [4]. In 1988, drought combined

with slash-and-burn agriculture caused large forest fires in the Amazon and 1 million hectares of forest was lost. The UN estimated the losses to be 100 rural houses, 14,000 cattle, and 700 silos affecting 12,000 people [5]. In Mali, drought is becoming more and more frequent, leading to drying out of soil and disappearance of vegetation. The lives of many people are on hold waiting for clouds which promise less and less rain. People's hope for better future is destroyed.

In all the years since 2000, Mozambique has been experiencing an acute drought mainly affecting the province of Gaza and Inhamitanga in the south. The greater part of the communities did not harvest anything in the agricultural field from 2003 – 2005; they are now living by consuming wild roots and selling firewood in the towns. Due to drought in many parts of Ethiopia, the crop production is reducing yearly especially in southern Ethiopia. In Boricha area of southern Ethiopia, 20,000, 30,000, 38,000 and 60,000 people were affected by food shortage in 2001, 2002, 2003 and 2004 respectively. In Rwanda, the temperatures are becoming higher and higher. The maximum temperature used to be 25°C, but has risen to 29°C. Moreover, the longest drought period used to be up to 4 months, but has increased to six to seven months. Rivers and lakes levels have also fallen and some swamps have dried up [5].

Floods

The rise in sea level has been linked with global warming by the IPCC. According to the IPCC [6], working with records over the last 100 years, has shown that a strong correlation exists between greenhouse gases emission and climate change and between global temperature and sea level rise. Global temperature is expected to rise by between 0.2°C to 0.5°C per decade. The rise in temperature is expected to cause thermal expansion of sea and melting of polar ice. These will cause the sea level to rise about 3-10 cm per decade during the next century.

Flood is becoming more frequent in many parts of the world especially in Africa. Some countries experience flood and drought at the same time. For example, Mozambique recorded the worst floods in 2000 affecting the southern and central region of the country. In Malawi, when it rains very well in the upper plateau, it causes flooding in the lower plateau. Such phenomena have become very frequent in recent years due to the problem of changing rainfalls coupled with deforestation. In August 1985, glacial lake outburst flood caused a 10-15m high surge of water and debris to move down Bhote Koshi and Dudh Koshi rivers in Nepal for 90km destroying many things including the Namche Small Hydro Project [7].

In Bangladesh, the frequency of flooding is increasing due to heavy rainfall or water coming from surrounding countries and creating water logging. In the Jessore area of Bangladesh, flooding was absent

until 1988. But in 1988, 1998 and 2004 the Jessore area was flooded. Periods of heavy rainfall over a very short period of time have been increasing over the last ten years in India. The frequency of cloud burst is increasing, where there can be 60mm of rain in five minutes. Two of such incidences have occurred in the last three years. Several incidences of flash flood have been seen even in desert areas where drought was previously experienced.

Change in Rainfall Pattern

Observational record has shown that since the mid 1970s, precipitation has decreased across Africa. Many communities in Africa practice rain-fed agriculture. Decreasing precipitation will affect food security in the African continent. It will also lead to decline in water availability for people and livestock and for sustaining the wider environment. For example, in Burkina Faso, the amount of rain has reduced and the rainy season has become very hot. In Malawi, rainfall is becoming very erratic and there is less each year. The stream and rivers are drying up and the water table is now deeper than before. Reports from Mali revealed that climate change has affected water security. The rains have become very scarce and there is very little rise in water level. Because of this change, many have to walk several kilometers to look for water. The changes have caused forests to dry up and games have disappeared. In Mozambique, many wells have now dried up for the first time making many communities to live in great difficulty. Many have to walk a distance of 10 – 30 kilometers to fetch drinking water. Some do not wash every day in order to save water. In the past in Niger, the rains came for three months at a time and the temperature was quite cold. Now it only rains for two months or less; this trend started after 1984. There has been severe drought leading to the death of many animals. Ethiopia has experienced climate change affecting water security. The streams are drying up and there is decreased flow in rivers, lakes are shrinking affecting the habitat of birds and fish. Still in Ethiopia, ground water levels are getting lower, there is reduction in the volume of water for hydroelectricity plants. In the Rift Valley of Ethiopia, the use of water for soda ash extraction from Lake Abiyatta has caused the lake water to recede by as much as 3-4km compared to what it was 30 years ago.

Changing seasons and Food Security

Food security has been defined as the ability of people to grow and obtain food [2]. The World Resource Institute estimated that 70% of the African population lives by farming and 40% of all exports are agricultural products. The poorest members of the African society are those dependent on rain-fed agriculture for jobs and income making the continent vulnerable to climate extremes that disrupt agriculture. Across Africa, seasons are changing. In Ethiopia,

climate is affecting harvest because a delay in onset of rains forces farmers to miss the optimum planting time and farmers are unable to plant long-season crops. The growing season has become shorter due to the delayed onset and early cessation of rainfall. There is decline in crop yield and poor performance of root crops that require even distribution of rain. In 2004, due to Belg rain (March to May) shortage, yield loss of 80% at Boricha and 25% at Meta Robi was recorded.

The rainy season has become unpredictable in Mali. The first rains that used to come in May now fall during the last two weeks of June and the rainy season keeps shrinking. Planting times are affected because farmers can no longer follow the agricultural calendar. The water level falls year after year and some species of animals and vegetation have disappeared. The survival of the poor people is uncertain. Farmers are at a loss as to the time to plant in Malawi. Many years ago, rains used to come in October, but now rain begins to fall in December and it is never consistent.

Deforestation and Desertification

Forest covers 520 million hectares in Africa, making 17% of the world's forest. The forest is economically important to the African continent contributing up to 6% of GDP. Moreover, about 90% of Africans rely on firewood for their energy requirements. African forest is being destroyed at an alarming rate. In the 1980s, Africa lost 47 million hectares of forest. Climate change will add further stress to this already deteriorating situation. The IPCC predict that a sustained increase in mean ambient temperature beyond 1°C would cause significant changes in forest and rangeland cover. With global warming forest will be affected by more pest, pathogen and fire. Loss of forest will in turn lead to the encroachment of the desert in many parts of the world especially in Africa.

5. Climate Change in Nigeria

Coastal Erosion

The occurrence of coastal erosion has been reported in Nigeria by Okon and Egbon [8]. The report of Udofa and Fajemirokun [9] showed a rise in sea level along Nigerian coastal waters. They did a mechanical analysis of tide data from 1960 – 1970 and reported mean sea level rise to be 0.462m above zero level of the tide gauge. Also, the Nigerian Environmental Study/Action Team (NEST, 2004) [10], reported that sea-level rise and repeated ocean surges will not only worsen the problems of coastal erosion that are already a menace in the Niger Delta, the associated inundation will increase problems of floods; intrusion of sea-water into fresh water sources and ecosystems would destroy such stabilizing systems as mangroves, and affect agriculture, fisheries and general livelihoods.

The most important environmental problem facing the Niger Delta is coastal erosion. It is the most important impact of sea level rise in the region and should be given high priority attention. Flooding of low-lying areas in the region has been observed. Settlements in the coastal region have been uprooted by coastal erosion. In some places, especially in Forcados, some oil wells have been lost to the ocean due to erosion. Coastal erosion poses serious problem for the economic activities in the Niger Delta especially natural sectors such as farming and fisheries (about 50% of the fish consumed in Nigeria is from the Niger Delta). Coastal vegetation especially the mangroves have been lost to coastal erosion [11].

The Niger Delta of Nigeria could lose over 15,000 square kilometers of land by the year 2100 with a one meter rise in sea level. Calculations have also shown that a 20cm rise in sea level will inundate 3400 km² of the Nigerian coastland [12]. It is estimated that with a sea level rise of 30cm, about 1 to 2 million people will be affected. In all this, it is predicted that Nigeria will lose about \$9 billion as a result of the sea level rise while at least 80% of the people of the Niger Delta will be displaced due to the low level of the region [11].

Another adverse effect of sea level rise in the Niger Delta is the increased salinity of both surface and underground waters due to the intrusion of sea water. This will lead to the death of aquatic plants and animals that cannot tolerate high salinity. The brackish water is the home of several species of fishes and it is the breeding site for several others. The ecology of the brackish waters will be affected greatly by this phenomenon and this may lead to loss of species. Some terrestrial plants that have low tolerance for high salinity will also be affected. Sea water intrusion will have a serious impact on the food security in the region because of its impacts on coastal agriculture. The salinization of underground water will lead to shortage of fresh water. Inhabitants of the region depend on underground water as their main source of water for drinking and for other domestic uses. Still another impact of sea level rise on the region is the emergence of health-related hazards [13].

General Flooding

While climate change will lead to increase aridity and desertification in northern Nigeria, it will lead to increase in flooding in the southern part especially in the coastal regions. Apart from coastal erosion, flood in general has impacted negatively the livelihood of many communities in the region. Flood and erosion remove top soil, destroy roads, affect fresh water resources and threaten lives and properties. Many people have been rendered homeless by floods and several roads have been made impassable. The usefulness of several roads has become seasonal i.e. they are only passable during the dry months of the year.



Fig. 1. Flood in Benin City

The frequency at which floods occur in Nigeria has increased in the last decade. Floods paralyze economic activities in many towns and cities in the Nigeria. Major roads, some linking states are flooded causing hardship to motorists. When these roads were constructed, the flooding problems were not there, and the companies that constructed the roads probably did not anticipate the problem. One common consequence of flooding is increase in transport fare. Commercial drivers usually increase their fare to make up for the distance they drive to avoid flooded roads, thereby putting the burden on their passengers causing a general increase in the cost of goods and services.

Change in Rainfall Pattern

Meteorological data have shown that rainfall pattern in Nigeria has changed in the past decades. Oladipo [14] reported that the decline in rainfall in Nigeria started at the beginning of the 1960s when a decade of relatively wet years ended. According to him, the persistence of below-mean rainfall in the last two decades in Nigeria is an indication of an abrupt change in climate. Nigeria lies predominantly in the tropics having two seasons – the wet and dry seasons. The wet season occurs from May to September, while the dry season begins in October and ends in April.

The agricultural sector in Nigeria is highly sensitive to rainfall pattern especially in southern Nigeria where

rain-fed agriculture is mainly practiced. It has been predicted that climate change will pose serious threat to food security. Climate change creates uncertainty in the rainfall pattern (timing and amount) and affects agricultural activities. Agriculture in most parts of Nigeria is highly dependent on rain and irrigation is seldom practiced. The changes in the rainfall pattern have greatly affected the agriculture in the region. Farmers in the region begin cultivation at the end of the dry season, when the rain begins to fall. They plant their crops after the first or second rain in the month of March, and sometime in April. After the first rain, the rain falls periodically till the months of June/July (the peak of the rainy season), when rains fall more or less continually. The periodic rainfall pattern before the peak in June/July enables farmers to cultivate various crops.

Because of the change in rainfall pattern, farmers who plant after the first or second rain run into huge loss when the rains are delayed beyond the usual due to climatic changes. The crops are scorched causing huge economic loss. Before this time farmers could predict the rain and they knew precisely when to plant their crops. The crops after they are planted are watered periodically by rain before the peak of the rainfall in June. The amount of rainfall within the period before the peak is necessary for the optimum performance of

many crops most especially the maize which is widely consumed in every part of Nigeria [13]

6. Towards a Low Carbon Economy: Renewable Energy and Energy Efficiency

Renewable Energy

Renewable energies include wind, ocean wave and tides, solar, biomass, rivers, geothermal (heat of the earth), etc. They are called 'renewable' because they are regularly replenished by natural processes and are therefore in endless supply. They also can operate without polluting the environment. Technologies that have been developed to harness these energies are called renewable energy technologies (RETs) or sometime also called "clean technologies" or "green energy". Because renewable energies are constantly being replenished from natural sources, they have security of supply, unlike fossil fuels, which are negotiated on the international market and subject to international competition, sometimes even resulting in wars and shortages. They have important advantages as follows:

- a) Their rate of use does not affect their availability in future, thus they are inexhaustible.
- b) The resources are generally well distributed all over the world, even though wide spatial and temporal variations occur. Thus all regions of the world have reasonable access to one or more forms of renewable energy supply.
- c) They are clean and pollution-free, and therefore are sustainable natural forms of energy.
- d) They can be cheaply and continuously harvested and therefore constitute a sustainable source of energy.

Renewable energy can be set up in small units and is therefore suitable for community management and ownership. In this way, value from renewable energy projects can be kept in the community. In Nigeria, this has particular relevance since the electricity grid does not extend to many rural areas and in some cases it is prohibitively expensive to extend the grid to remote areas. This presents a unique opportunity to construct power plants closer to where they are actually needed. In this way, much needed income, skill transfer and manufacturing opportunities for small businesses would be injected into rural communities.

RETs have the potential to produce more jobs than fossil fuel or nuclear industries. When RETs are properly integrated into national development plans and implemented, they can substantially reduce greenhouse gas emission and simultaneously increase employment. Moreover, it can also enhance energy security by reducing reliance on oil and promote energy sovereignty. With the right approach, the interests of the economy and the environment can

come together when RE is properly integrated into development plans.

Wind Energy

The energy contained in the force of the winds blowing across the earth's surface can be harnessed. Such energy can be converted into mechanical energy for performing various tasks such as generating electricity, pumping water, grinding grain, etc. Modern wind turbines are being used to generate electricity in countries such as Germany, Denmark, India, China, and the United States to supplement more traditional sources of electric power. Design improvements such as more efficient rotor blades combined with an increase in the numbers of wind turbines installed, have helped increase the world's wind energy generating capacity by nearly 150 percent since 1990 [15].

Wind energy available in Nigeria varies from the extreme south to the extreme north. The wind speed in the south ranges from 1.4 to 3.0 m/s. The wind speed is higher in the northern Nigeria, from 4.0 to 5.12 m/s [16]. Nigeria possesses enormous potential to develop and utilize energy from the wind for electricity generation. The coastal regions of the south and the northern part of the country are possible suitable sites for wind energy exploitation. Wind turbines are suitable for power generation in remote places where energy is needed but costly to connect to a central source. They are particularly suitable for development of energy in rural communities in developing countries.

Solar Energy

Solar energy can be collected using artificial devices called solar collectors. The energy collected can be used either in a thermal process or a photoelectric (photovoltaic) process. When used in a thermal process, solar energy is used to heat a gas or liquid. In the photovoltaic process, solar energy is converted directly to electrical energy without intermediate mechanical devices. Nigeria is blessed with enormous solar radiation that can be harnessed; solar radiation intensity varies from 7.0kwh/m² in the extreme north to 3.5kwh/m² in the extreme south. These figures are sufficient for thermal and photovoltaic application [16].

Geothermal Energy

Geothermal energy is the energy obtained from the heat that originates from the earth's crust. Report shows that in 2004, over 9,000 megawatts of electricity were produced from 250 geothermal power plants in 22 countries around the world. These plants produced power for well over 60 million people living mostly in the developing countries. Some African countries have already started exploring the energy potentials offered by this renewable source of energy. Nigeria has some potential to harness energy from this source of renewable energy. There are two major geothermal

energy resource sites presently known in Nigeria. They are Ikogosi Warm Spring in Ondo State and the Wikki Warm Spring in Bauchi State. Outside these two major sites, other sites have been identified in the Lagos sub-basin, the Okitiputa Ridge, Auchi-Agbede within the Benin Flank/Hinge Line and the Abakaliki Anticlinorium [17].

The advantage of this source of energy is that it has a very high rate of security. More so, it is available for 24 hours a day all the year round. The capacity of geothermal plants can range from 20MW to 60MW. It is also not harmful to the environment: that is it does not contribute to the problem of climate change [17].

Energy Efficiency

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 **practices** and **products** that we use. If we use energy efficient appliances, it will help to reduce the energy necessary to provide services like lighting, cooling, heating, manufacturing, cooking, transport, entertainment etc. Hence, energy efficiency products essentially help to do more work with less energy. For instance, to light a room with an incandescent light bulb of 60 W for one hour requires 60 W/h (that is 60 watts per hour). A compact fluorescent light bulb would provide the same or better light at 11 W and only use 11 W/h. This means that 49 W (82% of energy) is saved for each hour the light is turned on.

When we talk about **end-use efficiency**, we refer to technologies, appliances or practices that improve the efficient use of energy at the level of the final user. For example the appliances we use in our houses and offices. As this term is not limited to electrical appliances, it can also be used for other areas of efficiency such as measures to improve the ability of houses to absorb and retain heat in winter and keep out heat in the summer. On the side of utility companies, providing electricity, they can also devise ways and technologies to promote the efficient use of energy. This is referred to **demand-side efficiency** or **management**. Demand-side management can be achieved by policies implemented by utilities and energy planners that encourage consumers to use energy more efficiently. An example of this is load shifting, which includes encouraging consumers to move their energy use away from peak period.

As we can see so far, there are two important ways we can approach the efficient use of energy. The first one is the **technological approach** while the second is the **behavioral approach**. For the technological approach, we need to change the type of technology we use to a more efficient one. A good example is the one we cited above on the light bulbs; replacing incandescent bulbs with energy efficiency bulbs. The behavioral approach entails changing the ways we do

things. An example is switching off appliances when not in use. Many of these behaviors will be discussed in the next section.

Importance of Energy Efficiency

Energy efficiency has become the key driver of sustainable development in many economies in the world. If we use energy efficiently, it will lead to the saving of personal income; families will not have to spend so much money paying for energy. 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. Furthermore, 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 in the residential, public and private sector, there will be no need to alternate electricity supply.

Most of the energy we generate in Nigeria comes from the burning of fossil fuel (oil and gas). For every kilowatt of electricity we consume, there is an equivalent emission of greenhouse gases (GHGs). Energy efficiency can help to reduce the emission of GHGs and reduce the reliance on petroleum to drive our economy. The negative environmental impacts associated with the generation of energy will also be reduced if we use energy efficiently. Many people can be employed during intervention programmes to change the behavior of people to use energy efficiently. For companies manufacturing electrical appliances, there will then be competition among them on who manufactures the most efficient appliances to capture the patronage of consumers.

7. Conclusion

So far, we can see that in Nigeria, we are already experiencing the impact of climate change. Developing countries, despite having contributed least to greenhouse gas emissions, are likely to be the most affected by the phenomenon for many reasons. They lack the institutional, economic and financial capacity to cope with changes. Therefore NGOs and other stakeholders in developing economies should initiate processes that promote climate change mitigation. Such processes may include advocacy for good environmental practices and for renewable energy and energy efficiency products. Reducing greenhouse gases, however, is not just a governmental responsibility. NGOs can assist with this by educating stakeholders on the effects of climate change and how their choices affect the poor. Provision should be made for integrating climate change considerations into national policies and programmes. There is need for country-driven activities for climate change mitigation

and adaptation. Nigerian NGOs can also help to mobilize strong public and political support for actions to mitigate climate change. The developing nations of the world should develop new strategies to reduce the emission of GHGs.

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