

A Review Of The Sustainable Development Scene In The United Kingdom And Nigeria

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Abstract: *This an illustrative case study of the sustainable development scene in the United Kingdom and Nigeria. The study reviews the concept of sustainable development within the context of the Energy sector. The study uses the UK and Nigeria as a representation of developed and underdeveloped countries respectively. The objective of the study is to highlight or identify disparity between developed and underdeveloped countries as regards sustainable development. The study identifies policy and technological tools used to address sustainable development in both countries. The study also highlights challenges to sustainable development unique to both countries. In conclusion the study assumes that there is a significant disparity between both countries.*

Keywords: *Sustainable Development, Energy, United Kingdom, Nigeria*

I. INTRODUCTION

Sustainable development can be defined as the “development that meets the need of the present without compromising the ability of future generations to meet their own needs”.^[2] It can also be defined as “a mode of human development in which resource use aims to meet human needs while ensuring the sustainability of natural systems and the environment so that these needs can be met not only in the present, but also for generations to come”.^[1] The concept of sustainable development has become more prevalent in recent years especially due to the challenges of climate change. The production and use of energy is fundamental to climate change issues and therefore needs to be understood. Sustainable development from the Energy perspective focuses on how energy resources are presently used in such a way that it does not compromise the ability of future generations to cater for their energy needs. Although climate change and resource depletion is a global issue, there seems to be a disparity between how developed and underdeveloped countries address the issue using sustainable development.

II. OBJECTIVE

The Objective of this study is to highlight or identify the disparity in Sustainable development between a developed and underdeveloped country. The study sets out to understand the current situation of developed and underdeveloped countries. This study is expected to provide a sufficient overview of what might be the current sustainable development situation of two different kinds of economy.

III. SCOPE AND METHODOLOGY

The study is an illustrative case study of Sustainable development as regards energy of developed and underdeveloped countries. The study focuses on the Energy perspective given that it is central to human activity and has direct consequences on climate change. The study uses the United Kingdom to represent developed countries and Nigeria to represent underdeveloped countries. The study is a qualitative study and relies on information reported in Public policy documentations, interviews and relevant writing samples.

IV. ENERGY POLICIES AND PROGRAMMES FOR SUSTAINABLE DEVELOPMENT IN THE UK

The Climate Change Act 2008 was passed into law in the month of November 2008 and was implemented in order to achieve efficient carbon management. The act accomplishes this by establishing greenhouse gas emissions targets such as the 80% reduction in GHG emissions by 2050 as well as creating new institutions with the responsibility of helping to meet those targets.^{[4][5]} The act further attempts to improve the management of already existing energy sector institutions and introduces a number of schemes and programmes such as the emissions trading scheme, community energy savings programme as well as carbon budgeting systems in addition to limiting the amount of credits the UK government can receive from the international community.^{[4][5]} This policy is supply oriented and is a reflection of the UK governments agenda to reduce GHG emissions and thus achieve some level of sustainable development.

Also, in the same period, when the Climate Change Act 2008 was passed into law, the Energy Act 2008 received royal assent in November 2008. This Act encourages the establishment of carbon capture and storage (CCS) infrastructure, renewables via the 'renewables obligation' with the aim that 15% of generating capacity would be from renewables by 2020.^{[5][6][7]} The act in addition makes provision for improving the management of existing energy supplies of the UK as well as incorporating other energy management strategies such as Feed-in-tariffs, smart metering and renewable heat incentives.^{[5][6][7]} This policy does showcase the UK governments determination to reduce GHG emissions especially by encouraging the development of infrastructure such as carbon capture and storage (CCS) which is designed to capture carbon dioxide from fossil fuel fired power stations, especially those using coal, and store it in a location where it is not harmful to the environment.^{[5][6][7]} In addition by promoting CCS and renewable obligations which helps diversify the UK energy mix, this policy encourages energy security which is a fundamental part of sustainable development. This policy not only focuses on the supply side of things but, by encouraging smart metering, it is also taking into consideration some elements of demand side energy management. Finally provision for the improvement of the fossil fuel exploration by improving offshore oil and gas licensing further strengthens the government's agenda on energy security.^{[5][6][7]}

The Energy Act 2010 improves upon the responsibilities of the office of gas and electricity markets (OFGEM) and enables them to increase the level of competition in the market so that consumer's interests can be made priority.^{[5][8]} The increase in competition encourages innovation and would lead to security of energy supply as well as ensure that energy is affordable.^{[5][8]} The new responsibilities of OFGEM ensure that other consumer issues such as carbon reduction are considered.^{[5][8]} The Act also encourages the installation of carbon capture and storage (CCS) which is a technology incorporated to fossil fuel power generation plants to reduce the level of carbon emissions.^{[5][8]} By taking into consideration the installation of CCS, the implication is that more fossil fuels can be burnt because its negative effect to the

environment would be curtailed by this technology and thus improving the chances of energy security and environmental impact mitigation.^{[5][8]} This act ensures that the goal of energy security and environmental impact mitigation do not conflict, however this does not mean that this approach is cost effective as we would discover in the following paragraphs below.^{[5][8]} The Energy Act 2010 received royal assent in April, 2010.^{[5][8]}

The Energy Act 2011 is a more demand side oriented policy that focuses a lot on the efficiency of energy in homes and businesses. It elaborates on the 'Green deal' programme and therefore makes room for increased levels of competition and the supply of low carbon energy.^{[5][9]} The Energy Act 2011 makes provision for landlords to receive incentives so that their properties can incorporate energy efficiency measures, and further states that properties without a certain minimum energy efficiency standard would not be allowed to receive rent by 2018.^{[5][9]} The Act also encourages the installation of low carbon technologies in order to improve energy security and efficiency.^{[5][9]} By encouraging the 'Green deal' the government is facilitating the reduction of energy demand which would have a positive effect on energy supply or security, and this is because the less energy is demanded the less pressure there is for more power to be generated and consequently there is a reduction of carbon emissions.^{[5][9]} Another way of looking at the effects of energy demand reduction is that, more energy is made available for other activities that could benefit society.^{[5][9]} The Energy Act 2011 was upgraded from the energy bill 2011 and does take into consideration both the supply and demand side of energy.^{[5][9]}

The "Green deal is a new financing framework to enable the provision of fixed improvements to the energy efficiency of households and non-domestic properties, funded by a charge on energy bills that avoids the need for consumers to pay upfront costs".^[9] in other words it is a financial incentive or mechanism launched by the department of energy and climate change (DECC) in order to encourage energy saving improvements in buildings, domestic or non-domestic.^[19] This energy saving improvement could include loft and wall insulations, installation of smart meters, installation of renewable energy generation technologies, etc.^[19] The green deal has four stages;

- ✓ Assessment stage: In this stage a green deal advisor is invited to embark on an inspection of the proposed building in order to identify areas where energy savings improvements need to be implemented and what financial savings can be achieved.^[19] The green deal advisor may refer the consumer to a green deal provider.^[19]
- ✓ Finance stage: After an energy savings report has been developed by the green deal advisor, the report can be taken to a green deal provider who will fund the required energy saving improvements.^[19] The consumer would be expected to sign a green deal plan which would also detail a payment plan with the green deal provider.^[19]
- ✓ Installation stage: The green deal provider may help the consumer acquire the services of an accredited green deal installer to implement the necessary energy saving improvements in the building.^[19]
- ✓ Repayment stage: The cost of installing these improvements is paid back via the consumer's electricity bills.^[19] The loan is charged to the meter of the building

benefiting from the energy saving improvements and not to the inhabitants of the building, therefore if occupants of the building change, the charge is transferred to the next occupant.^[19] A fixed Interest is usually added to the cost and applied over the duration of the green deal plan which would be shown to the consumer before sign up.^[19]

This initiative appears to be credible on paper however in reality its uptake has been unimpressive as many households are sceptical about it because they perceive the interest rates attached to it as very high and may be unaffordable. The DECC on the other hand argue the interest rates are relatively affordable and stable.^[30]

The Energy Bill 2012 makes provision for an electricity market reform (EMR), improvements in nuclear generation and pipe- line storage facilities and systems for the purpose of ensuring that low carbon energy is affordable and secure.^{[5][10]} The EMR was formulated to encourage energy oriented businesses to invest in low carbon energy sources particularly renewables and is also expected to expand the market capacity so that security of energy is realized.^{[5][10]} The EMR also makes provision for new fossil power plants expected to increase energy security but with lower carbon emissions.^{[5][10]} This bill also takes a focus on the nuclear generation of energy by creating entities that would ensure that more nuclear power plants would be built in the future in order to sustain energy security.^{[5][10]} The elements of this bill shows the UK's high agenda towards energy security and it is expected that more nuclear power plants would be built in the future. Although Nuclear power generation is a good source of generating clean energy, there are arguments that explain that the process of establishing these plants is detrimental to the environment especially in the event of a disaster, not to also talk about the cost of such projects and therefore has strong opposition.^{[5][11]} The bill's provision on improving pipe-line storage systems only further emphasises the energy security standpoint of this policy. This bill takes into consideration energy security and some level of environmental impact mitigation, however it does not emphasise a lot on the cost of achieving these goals.^{[5][11]}

ISO5001 is a set of standards and requirements developed by the international organization for standardization (ISO) for an energy management system (EMS).^[17] The standard covers a spectrum of elements including implementation and maintenance of an EMS and provides a systematic approach for organizations of all sizes to follow so that they can improve upon their energy performances.^[17] This standard is an opportunity for organizations to reduce energy use and cost and consequently improve upon reduction of gas emissions.^[17] The standards were developed by the ISO in response to the United Nations Industrial Development Organization (UNIDO) objective of combating climate change.^[17] The standard was therefore modelled after other standards such as the Quality management system (QMS) ISO 9001 and the Environmental management system ISO 14001.^[17] The structure of the ISO 5001 takes into consideration management procedures, policy, implementation and operations as well as a review process.^[17] A certification in the ISO 5001 standards is an indication that an organization is managing its energy properly and thus gives room for further improvements alongside changes in the standard.^[17] However

the ISO 5001 does not currently have accreditation by UKAS in the UK, however it is expected that it would achieve this before the end of 2013. UKAS is the body that accredits certification bodies.^[17]

The Feed - in – tariff (FIT) is a financial incentive scheme operated by the UK government to encourage the use of renewable electricity generation technologies in buildings.^[18] The renewable technologies covered by the scheme include Photovoltaic panels, wind turbines, hydroelectricity, anaerobic digestion and micro combined heat and power.^[18] The scheme provides benefits to participants in the scheme in three major ways.

- ✓ An energy supplier would pay the consumers a certain rate for every unit of electricity they generate from their energy generation technology.^[18]
- ✓ Consumers are also paid an additional rate or tariff for every amount of energy they export to the electricity grid. The current rate is about 4.64pence per kWh.^[18]
- ✓ Consumers would be able to make significant savings on their energy bills, because they would not have to pay as much to their energy suppliers to use energy.^[18]

The department of energy and climate change (DECC) is responsible for making government policies related to this scheme while the office of gas and electricity markets (OFGEM) is responsible for regulating and administrating the scheme.^[18]

V. ENERGY TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT IN THE UK

Biomass is considered to be the largest source of renewable energy in the UK because it represents about 39% of total renewable energy.^{[13][15]} It "*refers to living and recently dead biological material that can be used as fuel*".^[14] This technology is based on the fact that certain materials store energy from the sun as a result of the process of photosynthesis and therefore have the potential to release energy when the biomass material is burned.^[13] There is a variety of sources from which biomass can be obtained and they range from living things to non-living things such as plants respectively.^[14] Another concept in this technology category is biofuels which is produced from biomass and exist in different states from solid to liquid biofuels and even biogases, depending on its proposed use, either for producing electricity or for powering vehicles.^[12] The use of biomass in the UK has been tremendous, so much so that energy produced from this technology or source had an increase of over 650% in 2004 when compared to levels in 1990.^{[12][13]} Despite its immense use in the UK this technology still has several challenges that it faces, such as the food versus energy debate where biomass is considered as competition with agriculture.^[12] What this debate suggests is that if we use available land to cultivate plants that can be used as biomass the option of using that same land to grow crops for food is limited and could lead to shortages in food production. Also, the exploitation of biofuels in certain parts of the world have been known to result in some ecological damage, which may be a possibility in the UK if appropriate measures are not put in place.^[12] In addition, the facilities that exist to support this

energy technology can be relatively expensive especially in the area of the transportation of biofuels.^{[15][12]}

Geothermal energy *“is the least exploited form of renewable energy in the UK.”*^{[13][14]} It refers to using heat from the earth's crust to generate electricity. This technology can be implemented on different scales based on the location, and it is usually very efficient and cost effective with the exception of the construction of the geothermal plant.^[13] The only geothermal scheme operational in the UK is the facility in Southampton, however it is expected that further schemes would be developed in other regions in the UK such as county Durham.^{[15]..[12]}

One of the most commonly used technologies in the world is Hydroelectric power which is almost considered clean because it does not produce any form of pollution except during its installation phase.^{[12][14]} This technology is not very complicated and involves *“the production of power through the use of the gravitational force of falling or flowing water.”*^{[14][12]} 18% of renewable energy generation in the UK as well as about 1.8% of general installed generating capacity for electricity was ascribed to the contributions of hydroelectric power in year 2012.^[15] One of the major advantages of Hydroelectric power is that it can be deployed on varying levels or scales depending on how much energy is required to be produced and how large the source for generation is, there can therefore exist large scale hydroelectric dams, micro hydro systems and Run-of-the-river hydroelectricity systems.^{[12][13]} Other challenges attached to this technology are ecological and it is often argued that the development of dams can often displace aquatic life and therefore disrupt certain ecosystems.

With the introduction of the feed – in – tariffs Solar power technology has further received prominence in the UK public.^[15] *“At the end of 2011, there were 230,000 solar power projects in the United Kingdom, with a total installed generating capacity of 750 megawatts (MW). By February 2012 the installed capacity had reached 1,000 MW.”*^[15] This technology involves the use of *“energy from the sun in the form of solar radiation for heat or to generate electricity.”*^[13] The applications for the use of solar power varies from solar architecture to heating and even solar cooking and it is proposed that about 20,000 MW of installed electricity capacity would be generated from this technology by year 2020.^{[13][15]} Solar power make use of photovoltaic (PV) which is the element that actually absorbs the radiation of the sun that can be used to generate electricity. Solar power technology has improved a lot over the years and the demand for it has also increased which has caused its cost to be reduced as well, however it is still considered to be relatively expensive.^{[13][15]} In addition this technology has challenges with respect to electricity storage, positioning and location of PV equipment's and the availability of sunlight, especially in the UK.^{[13][15]}

Another major contributor to the UK energy mix is Nuclear power and it involves the breakdown of heavy atomic nuclei such as uranium via atomic fission to generate useful heat and electricity.^[40] The UK has in operation 9 nuclear power stations which contribute about 16% of total energy generated in the UK. Nuclear energy is considered to be clean energy because there are zero GHG emissions in the process

of generating energy.^[40] However this argument is often flawed by the fact that the construction process of a nuclear plant which require heavy machinery that make use of fossil fuel is not pollutant free. There is also the challenge of the probability of a nuclear disaster, either due to a terrorist attack or natural disaster.^[40] Although the UK is not prone to major natural disasters such an earthquake which has the potential to damage a nuclear facility, it is a major concern especially amongst critics. Another challenge to this technology is the cost and lengthy time frame for its construction as well as the disposal of its radioactive waste.^[40]

Wind energy is covering a lot of grounds in the UK and is considered the second largest renewable energy source in the UK.^[15] This technology involves *“the conversion of wind energy by wind turbines into a useful form, such as electricity or mechanical energy”*^[12] and can be installed in various capacities depending on how much energy is required to be produced. The normal practice is to install wind turbines in locations that experience higher wind speeds and can either be installed offshore or onshore, the typical wind turbines have diameters ranging between 40 and 90 metres.^{[14][31]} Onshore wind refers to installations of wind turbines on land, while offshore refers to turbine installations at sea.^[12] The UK's yearly average wind speed ranges from about 5 meters per second to about 10 meters per second above ground level and thus has great potential for the wide scale implementation of this technology and this is supported by the fact that it is the eighth largest producer of wind energy worldwide.^{[15][16]} Over 5 Gigawatts (GW) of electricity capacity was estimated to have been installed in 2011 while it is expected that 2GW of installed electricity capacity would be deployed annually.^[15] This technology has several benefits especially as it relates to sustainable development because it is renewable and therefore supports the goal of environmental impact mitigation as well as promote energy security. However wind energy accrues to itself several challenges such as the fact that it is relatively expensive.^[12] The ratio of input in terms of investment and machinery to output is much higher than other non-renewable energy sources i.e. the amount of turbines and financial investment you would require to produce a certain amount of energy is higher than the inputs used to generate that same amount of energy using other non-renewable energy sources.^[12] Another challenge faced by this technology is the fact that it causes noise pollution, spoils the countryside as well as poses a danger to birds and even aeroplanes. In addition to this though wind power is considered clean it is often argued that the process of installing wind turbines is not clean and thus causes some level of pollution to the environment. In the same vein the total reliance on wind energy may imply intermittent power supply since energy generation is dependent on wind speeds which are inconsistent. Currently in the UK and in Europe it is often argued that this technology is relatively mature and it does have great potential for the future of sustainable development in the UK.

Ocean power is one of the least used energy technologies in the UK for several reasons, such as the fact that its economic viability is questionable and the limitation in its research and development due to low funding.^{[12][15]} About 5000 homes are expected to be supplied from this source of

energy, from the installation of eight under water turbines by a British Energy Company, lunar energy.^{[12][14]} Also it was made known to the public that this technology would generate about 3MW of electricity in 2007 which was estimated to cost about 4 million pounds.^{[12][15]} The principle behind this technology is not complicated and involves the use of the ocean, wave and tidal movement to generate energy.^{[12][15]} This technology is often confused with hydroelectric power because they both involve the use of water even though there is a distinct difference in how they operate.^[14] Ocean power can still further be sub-classed into tidal power and wave power, and In a little more detail the Wave power technology uses a "floating buoyed device" that converts the mechanical energy it generates from being shaken by the waves to electricity.^{[12][14]} In the same vein mechanical energy is being converted to electricity when it comes to tidal power, however this mechanical energy is generated from the movement of tidal stream generators which resemble propellers as a result of the movement of tides.^{[12][14]} This technology has great potential in the UK if more investment goes into it, because the UK is mostly surrounded by water with the presence of many waves and tides. The Severn Barrage is an example of the possible application of this technology has been talked about for several years without any implementation. This technology is considered as renewable and would benefit the cause of sustainable development in the UK with the exception of affordability.^{[12][14]}

Carbon capture and storage (CCS) is also known as carbon capture and sequestration and it's the process whereby carbon dioxide is captured by a scrubbing technology from large fossil power plants and transported via pipes to a storage facility which is usually an underground geological formation.^[20] The idea of CCS is to help reduce the amount of carbon emissions being released by fossil fuel plants, so that more energy can be produced from such plants without having a negative effect on the environment.^[20] The application of CCS is beneficial not only to the environment but economically too especially in the oil and gas industry, because carbon sequestration can be used in the extraction of crude oil.^[20] Carbon capture and storage is currently the best way to minimize carbon emissions from fossil fuel plants. However the technology has been criticized as being too expensive to install especially in instances where the sequestration site is far away from the power plant.^[20] Also the storage of carbon dioxide in geological formations under water might increase the chances of ocean acidification.^[20] The technology has also been criticised because of the risk of possible leaks from the storage sites to the atmosphere.^[20]

VI. CHALLENGES AND BARRIERS TO SUSTAINABLE DEVELOPMENT IN THE UK

The increase in population size in the UK is a major challenge to the implementation of sustainable development because there is a direct relationship between population size and energy use.^{[3][32][33]} The more individuals are in a location the more it is expected for them to make use of greater amounts of heating, electricity and transportation.^{[3][32][33]} The use of more of these energy services has implication on the

supply of energy, because in an attempt to meet up with the demand of the economy more energy would have to be generated from fossil fuel power plant's which is unsafe for the environment. Energy services can be defined as "the benefits people get from using energy in their homes – e.g. warm rooms, hot showers, well-lit spaces, access to the internet".^{[3][34]} The UK is one of the most sort after destinations in the world because of its developed economy and its tourist attractions and it is expected that over 2 million people would migrate to countries such as the UK between 2009 and 2050.^{[3][32][33]} This challenge is not only peculiar to the UK but can be viewed from the global perspective as well because global population is expected to increase from about 6.9 billion to about 9 billion by the year 2050.^{[3][32][33]} What this means is that if necessary steps are not taken to help minimize the use of energy, either by developing more renewable energy generation technologies or improving energy demand there would be a higher level of energy crisis.^{[3][32][33]}

Another major challenge to sustainable development in the UK is the level of consumer ignorance towards sustainable development and consumer energy behaviour.^[3] Sustainable development is a relatively new concept in Europe and in the UK, and several individuals have not yet fully understood the concept while some others do not even know what it is.^[3] Though the government has put in a lot of effort to incorporate the concept of sustainable development in its policy and through various schemes, several individuals and organizations still have negative habits towards the use of energy.^[3] A typical example is the fact that consumers purchase goods and services that are not energy efficient but yet cheaper because of their lack of knowledge in the use of such tools such as energy labels.^[3] They therefore are unaware of the long term cost they are incurring to themselves as a result of not purchasing energy efficient products. Another example is that many individuals are not privy to the use of smart meters and therefore cannot graphically see how they use their energy for them to make positive changes.^[3] Many times consumers are not properly informed of what they need to do as regards sustainable development because it is often costly and tedious to obtain such information.^{[3][35]} Several organizations do not have an energy management team that would take up the responsibility of engaging management and staff with sustainable development activities and are therefore left to participate in energy inefficient activities. "It is frequently argued that effective energy conservation requires more informing consumers about energy consumption, for example through smart meters at home or Eco labels while shopping. People need practical and tailored advice on how to reduce energy consumption in order to make change easy and lasting."^{[3][35][36]} Furthermore the world is changing to a more globalized and modernized society and many goods and services that were considered to be luxuries are having the characteristics of necessities in present day because people's attitudes have changed over time. For example the number of households that do not heat their bedrooms is less than 3% presently^[34], which was not the case when about 49% of households agreed that it was not necessary to heat their bedrooms in a national survey in 1977^[37].

In the bid to meet up the EU targets on carbon emissions by 2020, the UK has committed itself to reducing the amount of energy it generates from fossil fuel powered plants. If these power plants are not substituted by other generating plants there is a great chance of fall in electricity being supplied to the national grid which is usually referred to as the UK energy gap. The quickest alternative to solve this problem is to make us of gas fired power plants which implies that the UK government would have to increase its reliance on imports from countries such as Russia. By increasing their dependence on import, the UK government is shifting its autonomy to supply energy for its citizens and giving more power to foreign economies, because whatever happens to the economies of those they import from would directly affect the UK economy.

Technology is an important component to the realization of sustainable development, however there are still several technological challenges that the UK faces in the bid to achieve sustainability.^[3] One major challenge in this area is that there are still insufficient technologies to improve upon sustainability development because of the cost and the level of research required to develop such technologies, which consequently make them relatively expensive especially for everyday energy users. For example incandescent light bulbs are cheaper but use more energy, while energy saving light bulbs are more expensive yet save more energy.^[3] Even with the level of research and investment renewable technologies benefit from in the UK there are still several inefficiencies, for example wind energy has the disadvantage of being very noisy, spoiling the country side as well as possibly causing damage to birds and aeroplanes.^[3] In the same vein solar power has inefficiencies when it is concerned with the storage of generated electricity. Improvements in technology may bring about the 'rebound effect' which is a phenomenon whereby, energy efficient technology helps reduce energy use and carbon emissions, however making energy services cheaper and encouraging a higher increase of these services.^{[3][38]} The implication of this is that by making energy service cheaper as a result of developing more efficient energy technologies, there is a great chance of offsetting the changes made to initially reduce energy consumption.^{[3][38]} Therefore a lot of responsibility lies in the energy behaviour of consumers in the UK for sustainability to be achieved.^[3]

A very important component to the use of energy and consequently sustainable development is the **increase in transportation** in the UK.^{[3][39]} There is a positive relationship between transportation and the amount of energy used and increase in transportation would cause energy used to increase as well. However the implication of this is that several transportation modes in the UK are not environmentally friendly and are also not affordable such as air transport.^{[3][39]} Air transport for example makes up about 8% of the total energy consumed by transportation and is expected to grow by over 4% annually from 2012 to 2020.^{[3][39]} Air transport has minimal regulations as regards its carbon emissions and is therefore a major pollutant in the UK economy.^{[3][39]} In addition to this as the population of the UK increases it is expected that more individuals would make use of more transportation and consequently more energy.^{[3][39]}

Furthermore the misdirection of policy targets is also a major challenge of sustainable development in the UK. "For policy to be effective it has to take into consideration all aspects of sustainable development which includes security of energy supply, energy demand reduction, affordability and environmental impact mitigation. However It is argued that present policy is not focused on reducing energy demand but instead focuses more on how energy services are used efficiently".^{[3][34]} Furthermore "...Most of this (i.e. UK government policy) focuses on supply side renewable energy policies.....There is no significant government policy aimed at reducing demand for air travel, rather expansion of activity in this sector is being encouraged and planned for. Thus, current policy focuses not on reducing demand for energy services, accessibility or mobility, but instead tries primarily to increase the efficiency with which these services are provided."^{[3][34]}

VII. ENERGY POLICIES AND PROGRAMMES FOR SUSTAINABLE DEVELOPMENT IN NIGERIA

The energy policies in Nigeria are not properly documented for the public to view however the Energy policy 2003 the most prominent energy policy being implemented by the Nigerian government and it considers various aspects of energy generation from non-renewable generation to renewable generation. This policy and its elements is described below in Table 3.1.

Energy form	Policies
Oil	Increase refining capacity Endorse exploration looking for more oil reserves Privatize the oil industry Derive more economic benefits from the oil reserves
Natural gas	Utilize the nation's NG reserves into the energy mix More gas exploration Encourage privatization Eliminate flaring by 2008
Tar sands	Encourage tar sands exploration driven by the private sector Extract oil from tar sands
Coal	The nation will resuscitate the coal industry for export in an environmentally friendly manner
Nuclear	Pursue nuclear as part of the energy mix
Hydro power	Fully harness the hydropower potential (in particular small-scale) through environmentally friendly means and through the private sector Promoting rural electrification through Small scale hydro plants
Fuel wood	Promote the use of alternative energy sources to fuel wood De-emphasize fuel wood as part of the nation's energy mix

Solar	Help develop the capabilities to utilize solar energy
biomass	Promote biomass as an alternative energy resource
wind	Help develop capabilities to utilize wind energy
hydrogen	Help develop local production capacity for hydrogen
Other renewables	Will remain interested in other emerging energy sources.

Source: [28][29]

Table 3.1: Elements of Energy policy 2003

VIII. ENERGY TECHNOLOGIES FOR SUSTAINABLE DEVELOPMENT IN NIGERIA

Hydroelectric power is the second largest source of energy generation in Nigeria because it contributes about 38.1% of all electricity produced.^[25] Nigeria has a total of about 7 hydro power stations, 4 of which are in operation and the other three due for completion before 2018 to generate a total capacity of about 5225MW.^[26] Most of these power stations are poorly maintained and do not generate sufficient power to meet the country's needs. One of the major setbacks of this technology is the lengthy timescale and expensive cost for the construction of such facilities as well as the emissions being released during the construction process.

Though the contribution of Solar power technology to the generation of energy is insignificant, it has one of the greatest opportunities for success in Nigeria because it is estimated that Nigeria has average of 2,300 kWh/m² of solar radiation annually because of the geographical location of Nigeria.^[27] Certain cities such as Lagos have a solar radiation intensity of about 930W/m² on average and much higher figures can be recorded in the northern region of the country as they experience more sunlight and heat.^[27] Though this technology has great potential in Nigeria it is however relatively expensive for the majority of the public because most people in Nigeria are poor and live on less than a dollar a day. Despite the setbacks in the application of this technology in Nigeria, several state governments use this technology to power street lights and surveillance cameras. *"What Nigeria requires is an affordable solar energy technology and cheap appliances. Potential solar energy applications in the country include drying of agricultural products (the traditional use), water pumping, air-conditioning and refrigeration, electricity generation, desalination and distillation, cooking and water heating"*.^[27]

On the other hand Biomass/biofuels technology is one of the most widely used forms of energy generation in Nigeria especially in the rural regions. However its contribution to electricity generation is insignificant as only a few advanced forms of its application are being employed. However this technology has great potential in Nigeria because the country has access to several biomass materials such as waste and trees, and has sufficient land for the cultivation of crops for the sole purpose of biomass energy generation. However the most common application of this technology is in the form of fuel-wood or firewood which is used mostly for cooking and

heating of homes particularly in rural communities. This application has negative implications on the environment if appropriate policy is not put in place because it encourages deforestation which is the situation in Nigeria. About 80 million cubic metres of fuel-wood was estimated to have been consumed between 1986 and 1987 in which about 97% of energy is lost due to the inefficiency of fuel wood.^[27] Although this is mostly the case there are however positive applications of biomass technology especially in large farms in Nigeria. Several farms make use of biomass technology to generate electricity for daily farm activities such as irrigation, heating and processing of agricultural materials amongst several others. In an attempt to promote biomass the government have developed several fuel-wood plantations in many parts of the country, even though they are insignificant and have not been properly maintained.^[27]

IX. CHALLENGES AND BARRIERS TO SUSTAINABLE DEVELOPMENT IN NIGERIA

Political instability and corruption is a major and primary challenge to sustainable development in Nigeria. Nigeria is at the infant stages of democracy, and has previously been under the rule of authoritarian leadership and has been on the onset of several political crises which constantly give rise to burst of violence amongst various stakeholders in the Nigerian society. The frequent and unruly change of government and leaders, especially followings its independence from the British government in 1960 to the late 90's, has caused an impediment to sustainable development due to policy inconsistencies. Every new government or leader refuses to acknowledge the policies of previous governments and therefore do not encourage continuity in government policy. The present democracy is still very young and has proved incapable of handling the concept of sustainable development especially in the energy sector. Nigeria has a very unstable political environment which many times lead's to civil unrest in the Nigerian society and one element particular to the political environment in Nigeria is corruption. Corruption is like a virus that has plagued the Nigerian society for many years. This element has deprived the Nigerian society of the necessary development that is needed to improve the living standards of its citizens. Sustainable development in the energy industry involves ensuring that energy is secure, affordable and environmentally accommodative; however Nigeria lacks all of the characteristics of sustainable development because there is insufficient investment for the development of energy infrastructure because of theft amongst government officials. The factor of corruption poses a serious threat to the progress of sustainable development to the extent that Nigeria was ranked 35th most corrupt nation in the world.^[21] Corruption has taken its root so much in the Nigerian society such that it is perceived by the Nigerian public to be a way of life.

Another challenge to sustainable development in Nigeria is economic instability and high level of poverty. The growth of sustainable development in Nigeria has also been limited by the level of economic instability. Nigeria is a major producer and exporter of oil and gas and has a nominal GDP of over

200 billion dollars and a per capita income of over 1,500 dollars;^[24] however there is no sufficient development to back up these figures because only a small proportion of the Nigerian public have access to these resources. This phenomenon shows that a large proportion of the Nigerian populace is poor and is unable to afford energy resources that are sustainable. Because of the poverty level, there are several less developed cities in Nigeria that still make use of firewood which is obtained from deforestation, which is an unsustainable practice. The economic instability of the Nigerian government is driven by several factors such as capital flight which is a process whereby economic assets such as money rapidly flow out of the economy as a result of certain consequences usually economic.^{[22][23]} The occurrence of capital flight is usually as a result of political instability and frequent civil unrest in certain parts of Nigeria and the implication of this is that there is not enough investment to support deployment of renewable technology and education, so as to promote sustainable development.^[22] Another evidence of economic instability is the heavy debt burden on the Nigerian government which has caused funds which could be used for sustainable development to be diverted to the payments of these debts. Even though most of Nigeria's debt was erased in the early 2000s the culture of mismanagement and over borrowing did not improve and has further increased causing the effect of the debt alleviation not to be felt by society. Nigeria has a mono-economy and relies mainly on its export of oil and gas which is subject to global fluctuations which usually have a direct effect on the nation's national income. Because of the volatility of the oil and gas industry it is difficult for the Nigerian government to make significant progress as it relates to sustainable development. The Nigerian government sometimes relies heavily on aid from more developed nations and the country is therefore subject to the factors that affect those other countries. The implication of this is that if a more developed country goes through a financial crisis, it will have a negative effect on investment in Nigeria because it might mean a reduction in aid from such countries.

Furthermore, factors such as social unrest and minimal commitment to the rule of law are also responsible for the slow growth of sustainable development in Nigeria. The unstable political and economic environment of Nigeria has taken a negative toll on the social behaviour of its citizens therefore leading to social unrest such as riots, terrorism and even a civil war in the 1970's. The low level of individual income, partly caused by high levels of unemployment, has forced several youths to embark on violent activities which have slowed the progress of sustainable development. These frequent outbursts of violence have caused several energy infrastructures to be damaged as well as discouraged several investors from investing in sustainable development infrastructure. An example of this has resulted from the Niger Delta crises where a group of militants constantly sabotaged oil and gas infrastructures therefore limiting the availability of energy to the rest of society. The rule of law in Nigeria is ineffective partly due to the incompetencies of the enforcement agency and the ignorance of the Nigerian public. The inability of the Nigerian public to be committed to the rule of law encourages lawlessness and crime and this has a

negative impact on sustainable development. Another factor that contributes to social unrest is the fact that there are several ethnic and tribal conflicts which often have a negative impact on the drive for sustainable development.

Ignorance and high level of illiteracy is another major challenge to the promotion of sustainability development in Nigeria because it is difficult to enlighten and pass vital information on sustainable development to a populace that has the inability to read and write. Nigeria has a high percentage of un-educated and illiterate people and it is therefore difficult to educate majority of the citizens of Nigeria on what they can do individually to promote sustainability. The infrastructure for passing across information to the public is also not sophisticated enough as many individuals still do not have access to multi-media avenues such as the internet and therefore cannot participate in the sustainable development occurring worldwide. In addition to this the concept of sustainable development is not being addressed in educational institutions as well as in business organizations, therefore several individuals are left ignorant on what they can contribute to the promotion of sustainable development.

The Complicity and insufficient corporate social responsibility (CSR) of multi-national energy firms also serves as a major impediment to the progress of sustainable development in Nigeria. The presence of political instability and corruption in Nigeria has encouraged several large multi-national organizations not to take their corporate social responsibility seriously. This is a major issue in Nigeria which has led certain militia groups, especially in the Niger delta region, to sabotage energy infrastructure in response to multi-nationals not taking responsibility, after causing damage to the environment of communities around locations of operation. Not enough pressure is being put on these companies to partake in CSR and to take up responsibility for their negative actions. The implication of this is that there are several oil spills that have not been addressed by these companies, therefore causing there to be a negative impact on the economy and sustainable development as a whole.

Poor energy infrastructure and technical know-how is a major challenge because many of the energy infrastructures in Nigeria are poorly maintained because of little investment and attention. There is not sufficient technical knowledge on renewable technologies that would work in the geographical location of Nigeria because the educational system in Nigeria is poor and there is insufficient technical knowledge transfer from developed countries. The poor energy infrastructure encourages the waste of energy resources such as oil and gas therefore reducing energy security and sometimes damaging the environment. In addition there is not enough research and development going into the development of renewable energy peculiar to the geographical location and the economy of Nigeria.

X. CONCLUSION

This case study shows that there might be significant disparity between sustainable development in developed and underdeveloped countries, within the energy context. The United Kingdom which is a representation of developed

countries seems to be making significant effort to improve its sustainable development position. Its efforts are expressed by the number of policies and technology it has put in place to address climate change. We may assume from the case study that the discussion on Sustainable development is active in the UK. On the other hand it appears that Nigeria which is a representation of underdeveloped countries is not active in improving its sustainable development position, at least when compared to the UK. Its position is expressed by the limited number of policies and technology to address the issue of climate change. A major limitation of this study is allowing the UK and Nigeria to represent all developed and underdeveloped countries respectively. Several countries have different economic structures and without empirical evidence, the representation of developed and underdeveloped countries in this study is flawed. Although the study suggests the UK and Nigeria might have different or opposing sustainable development positions, they both have challenges unique to them. These challenges need to be resolved within the context of their societies for sustainable development to be achieved.

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