The Built Environment Perspective of Climate Change- A Focus on Household Activities in Lagos Metropolis

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Abstract

According to current estimates, a variety of indoor activities like heating, cooking, cooling, lighting and other electrical activities are energy intensive with associated GHG emission. This paper therefore aims at investigating building related and household activities as contributory factors to global warming, climate change and environmental pollution. The study is a survey based research and involves the distribution of 120 structured questionnaires to households in Ifako area (which is a neighbourhood in Shomolu Local Government Area) of Lagos out of which 89 (74%) were returned for analysis. In addition 30 structured questionnaires were distributed to practicing estate surveyors in Lagos metropolis to ascertain their level of awareness of climate change and sustainability.

Findings from the study indicate that household activities are likely to trigger environmental problems like global warming and climate change. 72% of households still use incandescent bulbs while 91% use petrol generators (some of which are substandard) for power supply. It recommends improvement in power supply and better energy efficient practices amongst households

Keywords: Climate change, Carbon emission, Residential property, Sustainability, Green buildings

1. Introduction

A significant part of the man-made environment which provides setting for human activities is the built environment. The natural environment undergoes series of self-cleansing and replenishing cycle to maintain balance and sustainability in the face of expanding global population, industrialization, urbanisation, intensive agriculture and other human development activities. Beneath the surface of these varieties of human and natural activities lies a complex mix of unseen gaseous reactions as explained in the mechanism of green house effect.

The term '*green house effect'* refers to the natural process whereby a required amount of the sun's energy is trapped within the atmosphere by green house gases (GHG) to warm the earth and sustain life. Increase in human activities particularly the burning of fossil fuels in recent times keeps increasing the concentration of GHG with a resultant increase in the earth's temperature. The earth's average surface temperature is now within the range of 0.6-0.8°C and projected increase between 1990 and 2100 is put at 1.4 to 5.8°C (Ewings, 2008, Knight & Whitmarsh, 2009).Carbon dioxide (CO_2), an important and most common greenhouse gas (Karpagam, 2003; Bhatia, 2006) is significantly increasing the earth's temperature to give rise to a state of global warming. The effect of global warming produces extreme weather conditions and consequently abnormal changes in the global climate, hence the expression climate change. Recent reports of heat waves, droughts, floods, melting glaciers, rising sea levels, dwindling agricultural yields and unreliable weather patterns emphasis is the impact of global warming.

Climatic warning observed by scientists came to fore in 1979 when the first world climate conference was held. Since then, global efforts to address the severity of climate change began in 1992 in Rio de Janeiro when the United Nations Framework Convention (UNFCCC) held an Earth Summit on Climate Change signed by 154 nations. Subsequently, 178 nations who agreed to cut down GHG emissions signed the Kyoto protocol adopted by UNFCCC in 1997. Today, the Intergovernmental Panel on Climate Change (IPCC) set up in 1988, consistently documents existent and impending global threats of climate change.

Though the subject of climate change finds strong support within the preserve of natural sciences, the negative effect of global warming affects every strata of the society including the built environment an active part of the natural environment which is also the core of climate change. Buildings influence the environment through direct use of land, water and other raw materials and indirectly via consumption pattern of technologically processed products and services.

Of the many human activities associated with climate change, the built environment offers the largest cost-effective potential for significant long-term reduction in greenhouse gas emissions with substantial contributions towards the realisation of Kyoto protocol (United Nations Environment Programme (UNEP), 2007, 2009). The operational activities of buildings occupy the longest phase of an estate's life cycle thereby signifying the stage that consumes the greatest amount of energy and emits most of the GHG within the built sector.

The varied living patterns of Lagos residents provide a representative picture of the dynamics of Nigerian cities. Lagos state being the most populous city in Sub-Saharan Africa accounts for 40% of the total fuel consumption in Nigeria (Taiwo, 2005). Household activities within a mega city of about 18 million people living in over 3 million houses no doubt constitute a significant quota of carbon emissions in Lagos state. (Nigerian Muse, 2007; Lagos state Ministry of housing, 2009)

This position makes it pertinent to review the operational activities of residential buildings that contribute to carbon emission and also assess how the level of awareness of real estate professionals with reference to climate change influences the monitoring of carbon emissions in buildings in Lagos State. This line of reasoning informs the basis of this paper.

2. Literature Review

2.1 The Built Environment within the Global Climate

The subject of climate change occupies a centre stage in the deliberation of current events primarily because of its hold on the earth's environment which is the basis of all human and material wealth. The all-embracing reality of climate change impact opens up the opportunity for all fields of knowledge to make rational contributions for sustainable living. Since the built environment seeks to provide space and support for varied human activities that induced global warming, emphasis in this direction is both apt and timely. The built environment in quest of devising sophisticated ways to enhance the natural environment to suit a variety of preferences unwittingly fuels global warming. Globally, buildings consume over 40% of global energy use and one third of total GHG emitted come from buildings (UNEP, 2009). The art of allowing climate conditions to shape the built environment since the 1950s keeps declining in recent years (United Nations Population Fund- UNFPA, 2007) as stakeholders within the built environment place emphasis on profit maximisation, aesthetics and luxury at the expense of sustainability. Harnessing non-technological options and policies to reduce emission levels from buildings is rarely assessed and poorly understood (Levine et al, 2007). For these reasons, this write-up will review different facets of the built environment in connection to climate change by considering: Emission patterns of GHG within the built environment; Operational activities of the built environment and climate change; The economic impact of climate change and the built environment; The opportunities and challenges of real estate market in the face of recent climate developments; An overview of climate change issues in Africa; Conceptual issues of Climate change; Sustainability and the benefits of Green Buildings.

2.2 Emission Patterns of GHG within the Built Environment

The life cycle stages of buildings provide an organised pattern of connection between the built environment and the global climate. Firstly, the pre-development and development phase represents the construction stage responsible for industrial emissions of production and the deployment of construction materials. This stage also involves the use and conversion of virgin land into a variety of activities culminating in the destruction of carbon sinks (forests). Next is the operational stage, this is the occupational stage (the most active life of the building). At this stage, energy use is at its peak since household activities rely heavily on the use of fossil fuels, electricity and household appliances that are carbon and energy intensive. The demolition stage identified by Thorncroft (1965) as the total obsolescence stage represents the end of the useful life of the building when it is ripe for redevelopment and may include renovation process. At this stage, energy is also consumed during demolition and reconstruction.

The modest building life span of 40-60 years (Athena Institute, 2006) of existing buildings makes much of the built environment usually designed to last for upwards of 50 years (UK Climate Impacts Programme- UKCIP, 2010)obsolete in response to imminent misfortune of climate change. Simultaneously, most of these buildings in the prime of their life cycle become a repository of future carbon emissions as a consequence of their energy intensive design. Annually, 92 million tonnes of waste is generated from construction and about 14% (13 million tonnes) of this volume is composed of unused materials (Department of Trade and Industry- DTI, 2006). For these reasons, UKCIP (2010) recommends that active participants of the built environment require an understanding of future weather and climate events.

The inclusion of climatic behavioural factors into design of buildings will significantly influence energy consumption in occupied buildings which accounts for most of the energy consumed in a building's life. Estimates of energy use reveals that carbon emissions from buildings is about 300 milllion tonnes of co_2 annually in the U.K.; 45% in Europe and over 39% in the U.S. (UNEP, 2007; Binkley & Ciochetti , 2009). These estimates put buildings in a competitive position in comparison with other sectors in the issue of climate change. Further analysis of energy use in buildings indicates that more energy is consumed in residential buildings for a variety of activities like lighting, heating, cooling, cooking etc. In Europe, residential buildings accounts for 27.5% of the total of 36% of energy use in buildings, while the residential sector in Brazil consumes 23% of the country's electricity as against 19% consumed by the non-residential sector. In sub- Saharan Africa, a similar trend with a wide difference in magnitude is observed as the residential sector consumes as much as 56.2% of total energy in comparison to the meagre 2.2% consumed in the commercial and public sectors (UNEP, 2007). These contrasts in the estimate of energy use indicate that energy use is at its peak during the operational phase of a building's life and thus more carbon is emitted during this phase. In Lagos, the most populous city in sub-Saharan Africa (Taiwo,2005), energy consumption and carbon emissions in the transport sector is the highest as expressed in various anecdotal analysis in the print and electronic media within Nigeria in contrast with the international estimates earlier stated. This variation reflects the nonexistence of reliable data and in the case of Lagos prevents decision makers from giving attention to the built environment as another significant source of carbon emission.

2.3 Operational Activities of the Built Environment and Climate Change:

The occupation of buildings represents the consumption of building as a product and for obvious reasons accounts for the longest phase of a building's life span. The average life span of this phase is estimated to be between 50-100 years (Facoetti, 2002; UNEP, 2007). Additionally, a wide spectrum of sources acknowledges that buildings consume 90% of the active and passive lives of people. Hence, the indoor interaction between man and buildings represents a significant part of the built environment and this explains why stakeholders within the built environment strive to maximize the internal capacities of buildings. Far from public knowledge, recent developments in the climate partly but significantly reflects the downside of indoor activities. A variety of indoor activities like heating, cooking, cooling, lighting and other electrical activities are energy intensive with associated GHG emission but because most building occupants are ignorant of their environmental impact, these activities occur in improvident manners. Indoor activities make up the use/ operational phase of a building's life and subsequently accounts for the greatest proportion of energy consumed therein (UNEP, 2009). More importantly, increase in the trend of energy consumption during this phase recently estimated at 80% triggers over 80% GHG emissions from buildings and for this reason, the operational phase is expected to make up the larger share of the 40- 45% carbon dioxide and waste generated from the building sector in the developing world (UNEP, 2007, 2009; CSR, 2010). Specifically, more than four-fifths (84%) energy demands of buildings are used up during the operational phase for heating, ventilation, hot water and electricity (World Business Council for Sustainable Development-WBCSD, 2007). This position makes obvious the need to make indoor activities of the operational phase of buildings environmentally sustainable.

Across the globe, energy consumption pattern within buildings is a function of climate, building design, user need which informs occupants' behaviour, culture, occupancy ratio and socioeconomic development. Climate variation influences indoor energy use for heating and cooling purposes. Available global statistics reveal that space heating consumes 60% of residential energy in the developed nations with cold climate, while other heating purposes like water heating consumes 18% energy, 6% for refrigeration and cooking, 3% for lighting and 13% for other uses (UNEP, 2007). In hot/ warm climates like Japan and some parts of United States, more energy would be consumed for air-conditioning (Murakami, 1999; UNEP). In South–Asia and sub-Saharan Africa, provision of electricity is a top priority particularly for governments in sub-Saharan Africa where a significant proportion of the population are in dire need of electricity. Since access to electricity stimulates demand for electrical appliances which eventually increases energy consumption (UNEP, 2009) then provision of electricity for the vast population on the waiting list represents the potential increase of GHG emission in the near future. Poor access to electricity in sub-Saharan Africa justifies the use of biomass like wood for lighting and cooking which accounts for between 90-100% of the average household energy consumption especially in the rural areas (UNEP, 2007). Two-and-a-half billion people depend on biomass for cooking energy needs (Levine, 2007). In Nigeria, over 50 million metric tonnes of fuel wood is consumed annually for domestic and commercial use. This rate of consumption exceeds the replenishment rate resulting in the desertification of about 350,000 hectares annually (Sambo, 2009).

For the purposes of lighting, about one third of the globe's population as reported by Levine et al (2007) consume 3% of the world's oil supply (such as kerosene, paraffin or diesel) to provide 1% of global lighting and 20% of lighting-related CO_2 emissions. This analysis typifies the inefficient use of environmental resources which is the bane of global warming. Over 40% of primary energy demand in 11 OECD countries derives from household electrical appliances and consumes 70% of all appliance electricity use. Though energy demand for appliances in developing counties is small, it is expected to rise in the near future (Levine et al, 2007) as their standard of living improves.

2.4 Opportunities and Challenges of Real Estate Market in the Face of Recent Climate Developments

The pattern of activities within the real estate sector also illustrates the interplay of the economics of climate change and the built environment. The cliché that after life, property takes precedence in the wake of any incidence makes real estate relevant in connection to climate change. A clear understanding of how the magnitude or potential value of carbon emissions from buildings can guide investment decisions and operational activities of real estate is lacking (Binkley & Ciochetti, 2009). Also, the reality of carbon emissions generated by real estate is poorly perceived amongst building industry professionals as revealed by the survey carried out in Asia (China, India and Japan); Europe(France, Germany and Spain); North America (USA); and Brazil in South America (Binkley & Ciochetti, 2009). However, there is a growing realisation that improving energy efficiency in commercial and residential buildings can greatly reduce carbon emissions (Dixon,2009) and this presents a strong ground for sustainable real estate practice that can safeguard property investment against the vagaries of weather and at the same time help to cut down on the buildings' running expenses.

Climate change impacts will also affect real estate values. Property values in low-lying neighbourhoods may depreciate in the wake of flood and hurricane disasters. The incidence of hurricane Katrina created doubts about the prospects of real estate investments in that area (Rogers, 2007). In this instance the ripple effect of the uneven distribution of climate change impact (Stern Review ,2006) will probably soar up property values in high and inland neighbourhoods at the expense of coastal areas. Hence, value implications created by extreme weather provides a stronger incentive for consideration of sustainability in decision making process than the future financial benefits accruable from sustainable buildings (Dixon, 2009). In essence a continuous knowledge of climate impact on property values should complement the understanding of sustainability on real values which according to De Francesco & Levy (2008) can help valuers and academics to develop valuation tools for accurate assessment of property values.

Improving the carbon foot print of buildings in response to global warming creates opportunities for building users' and real estate managers to cut down buildings' maintenance costs. On the other hand the misfortune associated with global warming will push the concern of property insurance away from risk to the volatility and uncertainty of climate change impacts due to the increasing ratio of losses to premium revenues. Between 1980-2004 global aggregate impacts of property loss due to weather related disasters of climate change were the highest with insured property loss valued over $300 billion (Mills, 2007). Increase in average surface temperature also increased air-conditioning breakdown claims (Hartford Steam Boiler Inspection and Insurance Co, 2001, as cited in Mills, 2007). There is mass exodus from coastal areas with increasing number of non-renewed tenancies in the U.S. (Mills, 2007). This has however made insurers to innovate green insurance products that promote loss prevention in homes, offer premium credits for green features and rebuild green after loss (Mills, 2007). Along Barbeach in Lagos property values decline each time there is a serious overflow from the beach.

Carbon rating of buildings constitutes the most pronounced tool being used in recent times by real estate professionals in countries like UK, US, Canada to ensure longevity of buildings and reduced maintenance costs. The U.S. Green Building Council through the Leadership in Energy and Environmental Design (LEED) initiative and the Building Research Establishment Environmental Assessment Method (BREEAM) established in the UK in 1990, 8 years before LEED considers the environmental impacts of buildings in terms of energy, water, health, transport, land Use, waste, materials to rate the sustainability performance of buildings. Except for recent studies referring to countries like South Africa, Harare, Zimbabwe and Côte d'Ivoire (Le Treut *et al,*2007; Clevenger, 2008; Jones Lang LaSalle,2008), these forms of rating systems are conspicuously not in use within the African continent .

2.5 Sustainability and the Benefits of Green Buildings

From the aforesaid it is clear that the built environment would not only effect global warming but would be significantly affected by climate change impacts if business continues as usual. It is therefore important that the built environment align her pattern of activities to attain a neutral position in the emission of GHG. UNFCCC broadly classified the various initiatives developed in response to climate change impacts as Adaptation and

Mitigation (Klein et al, 2007).Generally, adaptation to climate change can be seen as direct damage prevention, while mitigation would be indirect damage prevention (Verheyen,2005). According to UK Climate Impacts Programme (2010), the built environment is identified by central government as a priority sector for adaptation to a changing climate. It is also one of the sectors where adaptation options must, of necessity, take account of mitigation, in order to ensure that adaptation responses do not create yet further increases in carbon dioxide emissions. The use of mechanical air-conditioning to provide cooling in the face of increased summertime temperatures is a simple example of this concept where mal-adaptation strategy that will increase greenhouse gas emissions.

In relation to the built environment, adaptation refers to measures taken to ensure that existing physical structures adjust favourably to evolving impacts of climate change. While Mitigation in anticipation of climate change impacts endeavour to develop structures and adopt activities that either emit negligible quantities of GHG or reduce current carbon levels. To present a clearer picture, Adaptation to a large extent fittingly applies to existing stock of buildings that have be upgraded to a standard that blends favourably with the environment and thus mitigate GHG emission while mitigation will ensure that new buildings are designed and constructed to be energy efficient and carbon neutral.

The definition of sustainability provides a consistent link between the goals of mitigation and adaptation. Sustainable development generally refers to the 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (Bruntland, 1987). Givo & McNamara (as cited in De Francesco & Levy,2005), defined sustainability as maximising positive effects and minimizing the negative effects of property ownership, management and development on society and the natural environment in a way that is consistent to investor goal and fiduciary responsibilities. The expression of '*present and future needs'* along with the phrase '*maximising and minimizing positive and negative effects respectively'* highlights the intent of adaptation and mitigation in both definitions. The opportunities sustainability offers in response to climate change cuts across various aspects of the built environment. Within urban setting, sustainability specifically require that agents of urban development ensure that the use of energy and materials within their jurisdiction maintains balance with the natural resources that the region can continuously supply in terms of photosynthesis, biological decomposition and biochemical processes that support life (Baba, 2004). Sustainability in this context fittingly highlights the concept of green development – an initiative designed to support environmentally friendly activities that complements the workings of the climate.

According to Kats (2003) *"Green or sustainable buildings use key resources like energy, water, materials, and land more efficiently than buildings that are just built to code. With more natural light, and better air quality, green buildings typically contribute to improved employee and student health, comfort and productivity"*. Perceptions of green or sustainable buildings varies with a wide range of design concepts that promotes the adoption of different innovations that are energy efficient, conserve water , reduce waste or simply environment friendly. Hence definition of green buildings will be both subjective and specific to taste and dictates of a geographic climate. Also the definition of green buildings is dominated by European and North American influences where the evidence of green practices is at least visible. For existing buildings, this would likely raise a *green* challenge as significant renovation, alteration or adaptation activities may be required to improve a building's energy use. How do green buildings achieve these benefits? Irrespective of their varied perceptions, green buildings set out to conserve energy, reduce waste and improve water usage.

GREEN BUILDING AND ENERGY: Energy demand within and around a building is consumed mostly for the purposes of heating, cooking, lighting, cooling and ventilation. These functions are achieved either crudely or by means of appliances or a combination of both with related GHG emissions. Features of green buildings imbibe high-tech and modern energy saving practices like sensor controlled and compact fluorescent lighting, high efficiency heat pumps, geothermal heating, photovoltaic cell arrays, optimum use of fresh air and natural light, harnessing natural circumstances for cooling and insulation into design to reduce energy used in operating buildings and prevent GHG emission (Commission for Environmental Cooperation-CEC,2008). Though traces of energy intelligent structures exists in Europe, Asia and Americas, In Nigeria, according to Efik (2007) technology innovation/transfer in terms of climate change mitigation or in terms of renewable energy and energy efficiency is Zero. Apart from the sparing use of solar devices for lighting in recent times, buildings of this nature are alien to most Lagos residents. However in some African counts like South Africa and Kenya their design are becoming green oriented. Available innovations for efficient energy use in green buildings include the use of biogas produced from fermented excreta, food or crop wastes using bio digester; windmills which provides a cheaper and cleaner source of electricity than fossil fuel; tidal turbines bolted to the seafloor; Solar thermal panels and photovoltaic cells that converts sunlight into electricity and the use of ground source heat pumps which uses earth energy to exchange heat within a building (UNEP, 2006). The use of pale colours on walls and ceilings can reduce energy used for lighting by 5 to 10% and this applies to all types of buildings except industries (RICS, 2007).

In Toronto, the retrofitting of an existing home with solar panels for heating water, improved insulation, new windows and appliances, a heat recovery system and phantom load switches will achieve an annual reduction of 60% in GHG emissions from 9.7 tonnes to 3.7 tonnes (CEC, 2008).Policies that encourage the adoption of these types of innovations outlined above should be pursued in a country like Nigeria where about 60-70% of the people neither have access to electricity or modern energy services.

GREEN BUILDINGS AND WASTE: Activities within and around the built environment generate waste with attendant environmental impact. By adopting the values of reduce, reuse and recycle in terms of building materials and construction waste, green buildings work to reduce waste, raw material usage and associated environmental impact as well as the cost of waste disposal (CEC, 2008). Green homes also maximise the use of local, reclaimed and recycled materials and enables on-site composting (Myers,2006). The enhancement of open space and the preservation of biodiversity under the concept of green buildings is a technique that naturally helps to manage wastes with minimal environmental consequences. During a construction project in Arkansas, USA about 97% of the existing building and paving material was recycled and 75 % of building construction waste was recycled (CEC,2008).

Green building features also help to build and promote healthy, vibrant, and economically strong community spirit (CEC, 2008). This is so because green building designs seeks to blend nature with modern and comfortable lifestyles and thus imposes on every resident a responsibility towards the community and a sense of belonging. A number of studies allude to the productive potentials and health benefits associated with green buildings. A variety of green building features such as improved energy efficiency, lower emissions due to better siting and better building material source control, significantly better lighting quality achieved through natural day lighting , improved thermal comfort and ventilation in buildings using underfloor air for space conditioning, increased natural air ventilation and moisture reduction, and use of low-emitting floor carpets, glues, paint and other interior finishes and furnishings contribute to healthy living and productivity of occupants (Kats, 2003; CEC, 2008; Dixon, 2009). Empirical analysis specifies the significant and positive correlation of increased productivity with increased ventilation, increased day lighting and lighting control and increased temperature control (Kats, 2003) and that productivity is about 1%- 5% higher than conventional buildings (Dixon, 2009). Better measured benefits were observed in tenants who live and work in buildings with green features (Kats, 2003). On the other end, poor indoor air quality found in traditional buildings attract huge hospital bills and lower productivity. Besides, green buildings significantly increases financial profits and long-term competiveness (Lorenz et al, 2008) thus many corporate organizations particularly in the UK are adopting the green initiative to enhance their corporate social status and accountability (Dixon,2009).

The concept of green roof presents another key feature of green building that bundle up a range of environmentally efficient features that would otherwise be fitted in different parts of a building into one whole. In Mexico, focus on green roof aims to provide natural habitat for biodiversity which also meets the need of landscaped recreational space, recharge aquifers, attenuate rainwater and storm water run-off, filter pollutants from rainwater, provide efficient thermal insulation and cooling and enhance roof aesthetics. Retrofitting and new installation of green roof is generally feasible on a variety of buildings subject to specific building requirement and preference of occupants between the option of intensive or extensive green roof (RICS, 2007; CEC, 2008)

3. Study Area and Method of Analysis

Lagos, the commercial nerve centre of Nigeria with a population of 9,013 million (NPC 2006) and with a growth rate about 3.5%. The most recent population and housing census conducted in 2006 reveals that apart from Kano state, Lagos state is the most highly populated state in Nigeria. According to the Lagos State Ministry of Housing (2009), Lagos is also the most populous conurbation in Nigeria and most populous in Africa. Currently, Lagos is estimated to be the second fastest growing city in Africa and the 7th fastest in the world. The Housing deficit as at 2008 is 5 million houses. The Housing stock is inadequate for the large population leading to the shortages and adding pressure to the rent and facilities of the existing infrastructure. The State has annual demand of around 1 million houses while the annual supply is not more that 10% of the demand, according to the Governor as at 2007.These statistics gives the state a place of concern and indicates the need to take proactive steps to monitor the current rate of GHG emission which inevitably will increase and further increase the tempo of world GHG emission.

The study covered the Ifako Ijaiye Local Government Area of Lagos state. Ifako is a neighbourhood in Shomolu Local Government Area which Lagos and has a total population of 402,673 and households population of 967. Based on physical counting Ifako have an estimated household population of 250. The choice of this settlement was informed by the mix of residents and their types of accommodation being the ones developed according to the standard of Lagos state Government. The resident mix include, low, medium and high density all embedded in the locality. This mixed pattern of living appropriately captures the energy need, supply and use relevant to this study.

In all 120 questionnaires were distributed randomly amongst the residents. After retrieval 89 copies were suitably completed for analysis. All the 30 copies of questionnaires distributed amongst real estate professionals practicing within Lagos metropolis were appropriately completed except one. While the questionnaires sought to assess the level of awareness of real estate professionals in respect to climate change and its impact on their practice, the residential activities within the study area as revealed by respondents will serve as a basis for rating buildings energy use.

4. Data Presentation

4.1 Housing Characteristics

Figure 4.1 presents the distribution pattern of the houses surveyed with 3/4 bedroom flats having the highest frequency and duplexes with the lowest frequency.

Further analysis as seen in table **4.2 below** reveals an average of 2 windows per living room depicting that ventilation in these living rooms are adequately crossed.

Number of people living in a house and in a bedroom is revealed in this section. The outcome shows that there are more houses with occupancy ratio of 4-6 persons. Houses with more than 6 persons approximately make up 12.6% of the housing population. The average number of person per house is calculated to be 5.1 persons (**table 4.4**) which means that on the average, find 5 persons occupy a house.

Appliances in various homes and their average quantity per home are highlighted in **table 4.6** below. While many homes have TV, electric iron, kerosene stove, refrigerator/freezer, generator, fluorescent and electric kettle very few houses have air conditioners, bath heaters and ring boilers but incandescent bulb, TV and fluorescent were available in many homes in large quantity. The average number of appliances per home (column 5 of table 4.6) shows that use of incandescent bulb is the highest in most homes approximately 8 units followed by fluorescent with 2.44 units per home. Also most homes have at least 2 units of TV. Incandescent bulbs are not energy efficient as about 90% of the energy released produces heat while only 10% produce light.

4.2 Use of Power Generating Sets

Of the 71 respondents that use generating set in their homes **(table4.6),** 91.3% of the total population use petrol to generate electricity while four respondents 5.8% of the total population power their generating set with diesel. 2.9% of the respondents use both diesel and petrol operated generators. Figure 4.2 gives the presentation of this distribution in a pictorial form.

The amount of petrol and diesel used for generating electricity per household presented in **figure 4.3** shows that most households use more than 10 litres of petrol per week. Similarly, more than 10 litres of diesel per week per household constitute the highest quantity consumed in homes that use diesel operated generating set. The frequent use of generators has obvious implication to climate change, Green home Gas emission (GHG), and related environmental pollution.

4.3 Quantity of candles used daily

In most households, at least 2 sticks of candles are burned per day as shown in **table 4.7.** This represents 41.2% of homes using 2 candle sticks in a day. 37.3 percent use just 1 stick in a day. While 15.7% of homes surveyed use 1 stick of candle for 3 days. Evidently, every home burns candle and thus emits carbon dioxide. It also has the danger of causing fire related hazards in buildings.

Out of 88 homes, 64 homes use incandescent bulbs (72.7%) as outlined in **table 4.8.** 60 households (68.2%) use fluorescent. While a very few percentage 11.4% and 17.0% use the two types of compact fluorescent-CFL bulbs (low energy bulbs) indicated in the options provided.

4.4 Electricity Supply

Electricity supply pattern within this community as depicted in **figure 4.4** shows that most houses are supplied with electricity from public mains for 2 days while alternate days had no electricity supply. This pattern of electricity supply is commonly illustrated with on and off days for example the supply of electricity for 2 days and an alternate day off is tagged as 2 days on, 1 day off. A substantial number of residents experience erratic power supply not predictable from Power Holding Company of Nigeria (PHCN) while only 10% have constant power supply.

4.5 Analysis of Level of Awareness amongst Real Estate Professionals

Responses from real estate professionals and property managers surveyed reveal a high level of awareness since all have knowledge of global warming/climate change.

As shown in table 4.13 at least 66.7% of the responses from real estate professionals were of the view that climate change has effect on property, 22.2% partly agreed to that fact while 11.1% were not sure. In comparison with the awareness level analysed above, the percentage of real estate practitioners who partly agree and those not sure about the effect of climate change on property suggests that the depth of awareness is shallow.

Most real estate practitioners perceive that climate change will affect property by a) increased cost of maintenance through provision of comfort e.g. air conditioner, special type of materials, generating set and so on, b) building management practice, c) deterioration of the building fabrics and, d) habitability of building due to increase in temperature.

Also, most real estate professionals (80.8%) do not specify the type of generating sets to be used by residents occupying properties they manage and thus allow tenants to use any type of generating set. While few specify the type of generating set to be used in the building, some few others base specification on the frequency of power supply within the concerned location. This explanation is presented in figure 4.5 below.

On the choice of lighting unit to be used, only 37% of the real estate mangers recommend the particular type of lighting unit to be used in homes they manage while the remaining 63% do not as reflected in table 4.12

The surveyors however recommend the use of energy saving appliances, bulbs such as white halogen bulb, inverter and battery, solar power and use of low and clean energy in other to reduce energy consumption in buildings.

5. Conclusion and Recommendation

The pattern of electricity supply analysed above presents a picture of the poor state of energy supply and the unsustainable consumption of energy within households considering the use of candle, incandescent bulbs and generating sets. The average of 5 persons occupying a dwelling units of compact sizes reveal that most homes are densely populated and thus indicate that energy consumption is highly intensive. Proposal of rating systems in Lagos will be effective on the basis of housing size and occupancy ratio, as well as the appliances used for lighting and ventilation purposes.

It is however clear that though Africa at the moment is the least contributor of GHG in the globe, the continent however runs the risk of being a major contributor due to her various activities especially as it has to do with the built environment. The people of the continent are bereft of adequate orientation and sensitization as to what climate change is about, the danger and also the various practices that could mitigate the effect of climate change.

While the generally held opinion is that industrialisation engenders GHG emissions, this study has further revealed that the poor living standard of urban dwellers will not only contribute to the phenomenon but imminent environmental disaster looms if business continues as usual in the face of global warming particularly in strategic locations like Lagos where adequate infrastructure is lacking. The power supply system in the country is still far from being solved cultivating a fertile ground for the unsustainable use of fossil fuel. The Estate Surveyors and Valuers by virtue of their training have a key role to play in this direction. If real estate practitioners devote conscious effort to sustainable management of properties by initiating policies and developing a blue print for efficient use of environmental resources which also requires substantial government support, they would in no small way contribute to mitigating GHG emission.

Further areas of study particularly the need to quantify carbon emission from buildings and the cost implication of practices such as the use of alternative power supply and the purchase and of use home appliances has been opened up by this study.

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Table 4.2 Average Number of Windows per sitting room

Average number of window per sitting room	2.18 windows

Table 4.3 Number of People Living In a House

	FREQUENCY	PERCENTAGE
Only me	3	3.4
1-3 persons	32	36.8
4-6 persons	41	47.1
Above 6	11	12.6
Total	87	100.0

Table 4.4 Average Number of Person per House and per Bedroom

Average number of people living in a house	5.1 persons
Average number of person per bedroom	2.25 persons

Table 4.6 Available Home Appliances and Average Quantity per Household

	Available	Not	Quantity	Average
Electric kettle	60	28	70.8	1.18
Air conditioner	31	57	58.8	1.90
Air conditioner	36	52	56.12	1.59
Generator	71	17	88.75	1.25
Incandescent bulb	48	40	368.78	7.68
Fluorescent	66	22	161.21	2.44
Microwave	38	50	44.51	1.17
Bath heater	19	69	41.35	2.18
Refrigerator/freezer	73	15	111.78	1.53
Ring boiler	28	60	33.09	1.18
Gas cooker	35	53	42.90	1.23
Electric cooker	47	41	57.58	1.23
TV	88	0	180.57	2.05
Kerosene stove	79	9	116.78	1.48
Sandwich toaster	47	41	54.65	1.16
Electric iron	87	1	123	1.42

Table 4.7 Daily Burning of Candle Stick

CHARACTERISTICS	FREQUENCY	PERCENTAGE
Number of candle sticks burned per day		
1	19	37.3
2	21	41.2
1 stick last for 1-3 days	8	15.7
I don't use more than 2 sticks	3	5.9
Total	51	100.0

Table 4.8 Lighting Unit Types Used At Home

Lighting Units	USE	DON'T USE	PERCENTAGE OF USAGE
a) Incandescent Bulbs	64	24	72.7
b)CFL (type1)	10	78	11.4
c) CFL (type2)	15	73	17.0
d) Conventional Fluorescent	60	28	68.2

Table 4.12 Surveyors' Practice and Awareness on Global Warming

Awareness About Global Warming	FREQUENCY	PERCENTAGE
Yes	29	100.0
No	0	0
Total	29	100.0

Table 4.13: Effect of Global Warming on Property

	FREQUENCY	PERCENTAGE
Yes	18	66.7
Partially	6	22.2
Not sure	3	11.1
No	0	0
Total	27	100.0

Table 4.12: Recommendation on Type of Lighting Unit

	FREQUENCY	PERCENTAGE
Yes	10	37.0
No	17	63.0
Total	27	100.0

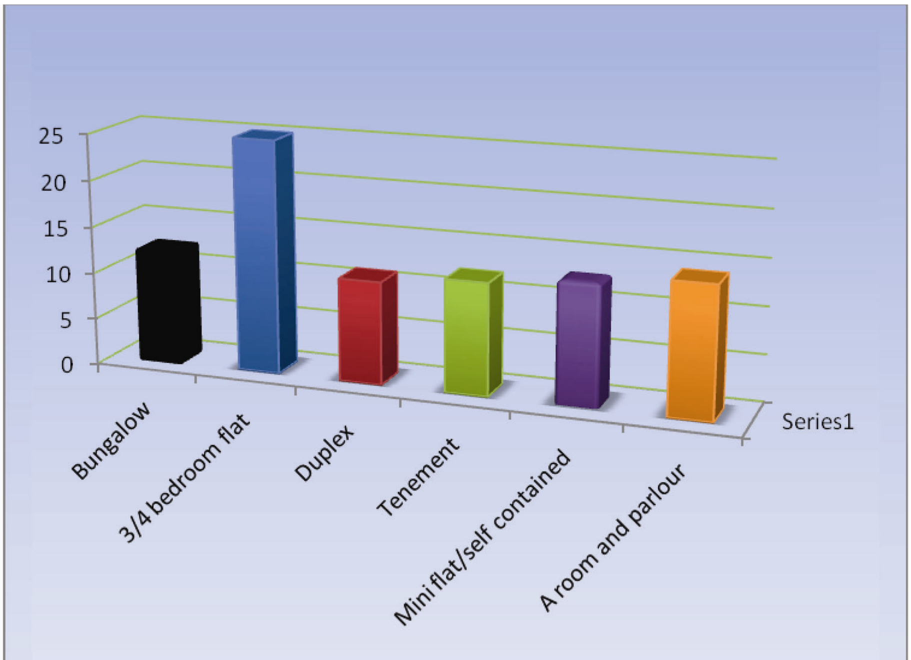

Figure 4.1: House Category

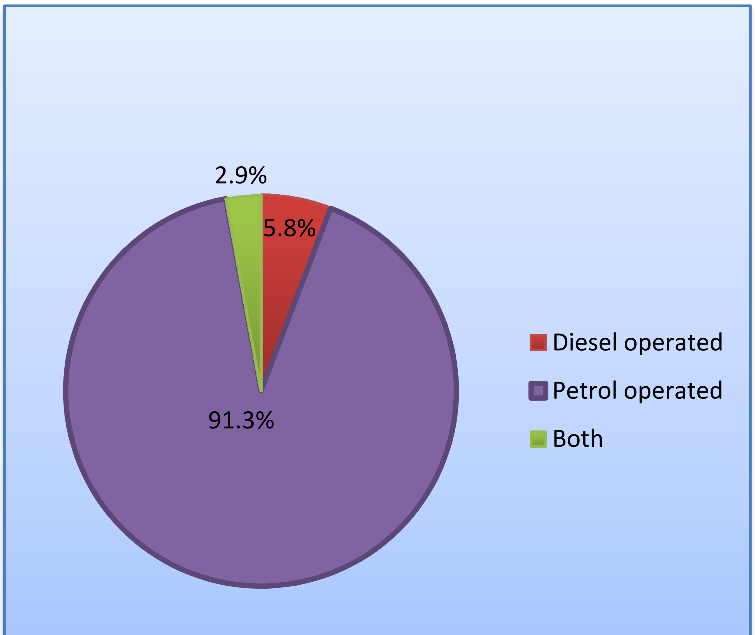

Figure 4.2: Generating set type

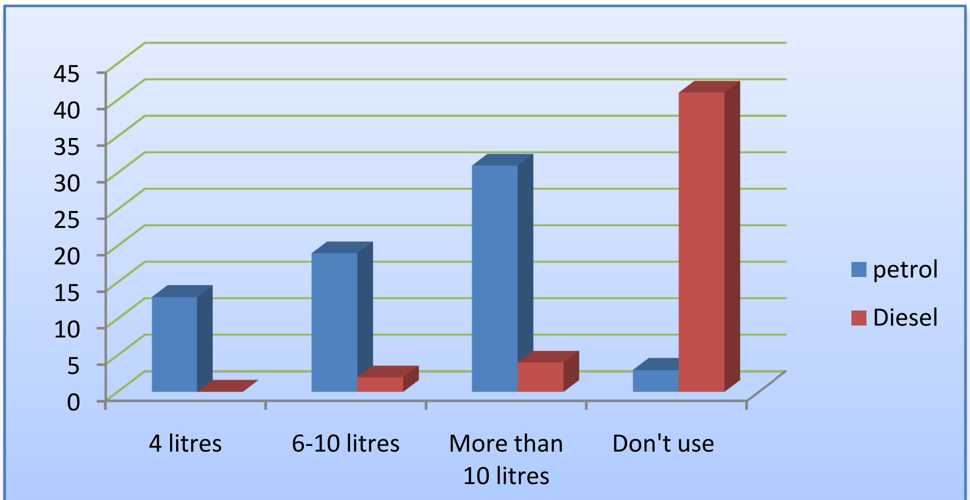

Figure 4.3: Amount of Litres of Petrol and Diesel Used

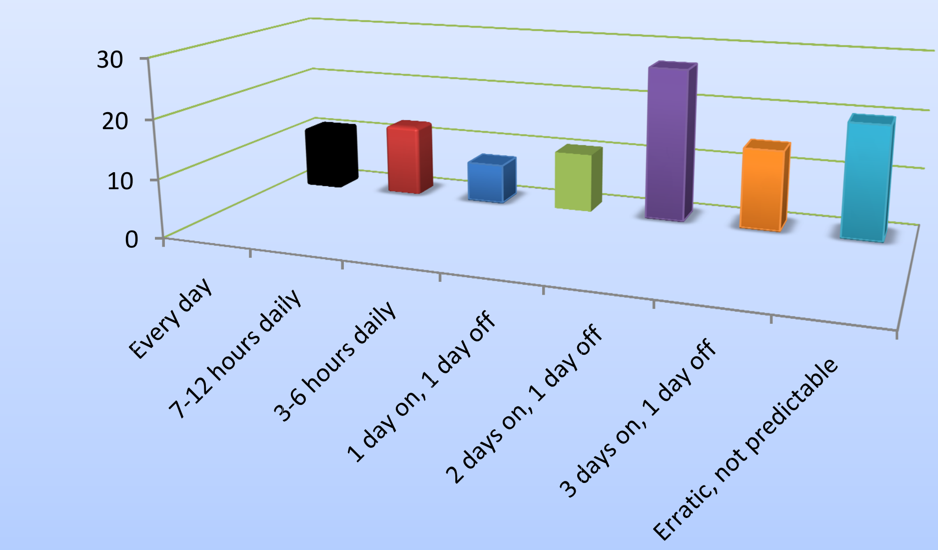

Figure 4.4: Nature of Electricity Supply

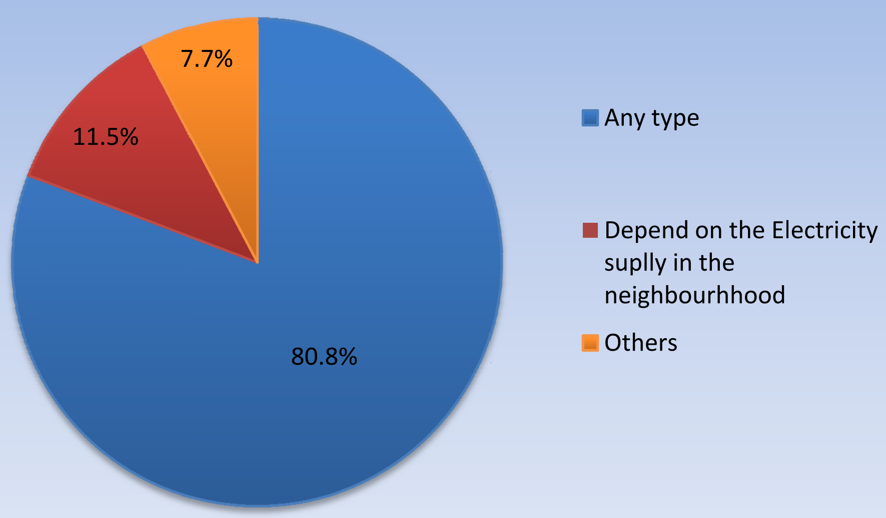

Figure 4.5. Type of Generating set allowed in the building