Journal of Multidisciplinary Engineering Science and Technology (JMEST)
ISSN: 3159-0040
Vol. 3 Issue 1, January - 2016

Deployment Of Smart Technologies For Improving Energy Efficiency In Office Buildings In Nigeria

Aisha Shehu Isa[1], Yakubu Aminu Dodo[2], Henry Ojobo[3], Ibrahim Abubakar Alkali[4]
[1]Department Quantity Surveying, Faculty of Environmental Technology,
Abubakar Tafawa Balewa University, P.M.B 0248 Bauchi, Bauchi State, Nigeria.
[2]Department of Architecture Faculty of Built Environment,
Universiti Teknologi Malaysia, 81310 Skudai, Johor Bahru, Malaysia.
[3]Department of Architecture, Benue State Polytechnic Ugbokolo, Benue State Nigeria.
[4]Department Architecture Faculty of Environmental Technology,
Abubakar Tafawa Balewa University, P. M. B 0248, Bauchi, Bauchi State, Nigeria.

[1]aishaisashehu2@gmail.com, [2*]yadodo@utm.my, [3]ojheny@gmail.com, [4]consultalka@yahoo.com,

***Abstract*—This paper examined smart technologies and energy strategies for improving the energy efficiency and reducing GHG emissions in office buildings in Nigeria. In addition, strategies for integrating energy efficient as well as zero carbon technologies for lighting, air conditioning and cooling as well as sustainable energy consumption in office buildings in the country are presented. Furthermore, an overview of the current renewable energy technology (RETs) policies and strategic energy roadmaps in Nigeria were highlighted. The findings of the study demonstrated that energy efficiency and GHG emissions mitigation in office buildings can be achieved by applying the three pronged approach of reducing energy consumption, deploying RETs, and GHG emissions monitoring. Finally, the paper concludes that policy enactment in addition to energy advocacy can potentially reduce energy consumption, GHG emissions and promote energy efficiency; which are required for ensuring a clean and sustainable future for mankind and its future generations.**

Keywords—Smart Technologies, Energy Efficiency, Office Buildings, Nigeria.

I. INTRODUCTION

Nigeria is Africa's largest oil exporter, economy, and most populated country with over 150 million citizens and gross domestic product (GDP) of $568.5 billion. However, sustainable growth and national development has remained a pipe dream since independence in 1960. As a result, the nation is perpetually plagued by numerous social upheaval, economic crises and geopolitical challenges. These problems have been blamed on tireless corruption, slow government bureaucracy, inconsistent policies, prevalent political uncertainty, poor security and incompetent judiciary system. Therefore, Nigeria is devastated by inadequate power supply, dilapidated social infrastructure, as well as poor health care delivery, widespread illiteracy, poor sanitation and inadequate housing [1-3].

Many analysts and policy makers in the country posit that to spur growth and development, the nation requires policy reforms and strategic investments in human capital development, social infrastructure and sustained energy supply[4]. In particular, concerted efforts and resources needs to be directed at developing the nations vast crude oil, natural gas and coal reserves in order to address the lack of adequate energy supply [5]. This will greatly address the nation's perennial energy crises and spur business activities, provide jobs and improve standards of living in the polity. Currently, many households, businesses and commercial establishments rely heavily on highly polluting, inefficient and unsustainable petrol and diesel generators for their energy supply [6-8]. Studies by global energy agencies opine the present trends in energy consumption and supply have become socially, economically, and environmentally unsustainable.

At current estimates, global energy related greenhouse gas (GHG) emissions are expected to double by 2050 heightened by an increased oil demand, apprehensions over security of future supplies and energy consumption [9, 10]. As a result, the innovative strategies such as novel transport, renewable energy, carbon capture and storage (CCS) technologies are urgently required to effectively reduce GHG emissions. In addition, global patterns in energy consumption and climate trajectories will require the deployment of energy-efficient, sustainable materials or zero carbon energy technologies particularly for heating and cooling in buildings [9, 11-13]. Currently, buildings account for 20 - 40% of the total energy consumption and up to 80 % during their operational

life cycle [14]. Consequently, energy consumption in buildings accounts for over 3 Giga tonnes of CO_2 emissions per year [15, 16]. However, with housing experts predicting that the number of service sector buildings will soar by over 200 % around the globe, energy consumption and GHGs will also increase [9]. As a result, analysts estimate that GHG emissions will increase to 11.10 Gt in 2020 and 14.30 Gt in 2030 exacerbating the risk of climate change and endangering human health, safety and the environment. Conversely, the development and deployment of innovative/smart, energy efficient, renewable energy technologies can potentially address the challenges of climate change and the global energy crises. Furthermore, favorable policies and strategic roadmaps based on novel technologies and sustainable practices particularly in the fast growing office buildings sector in developing countries like Nigeria towards a self-sufficient energy economy. In general, measures for ensuring energy efficiency and mitigating GHG emissions in buildings can be broadly classified into three major paths namely; reducing energy consumption, deploying low-carbon renewable energy technologies, and monitoring future GHG emissions [17].

Therefore, the main objective of this paper is to examine smart technologies for improving energy efficiency of office buildings in Nigeria. In addition, the paper will identify strategies for integrating energy efficient as well as zero carbon technologies for lighting, cooling and sustainable energy consumption for office buildings in Nigeria. It will also highlight the role of renewable energy technologies in nurturing the clean energy revolution for the future. Lastly, the paper will outline the energy law and strategic policies for the development, diffusion and adoption of renewable energy technologies (RETs) in Nigeria.

II. ENERGY EFFICIENCY AND MITIGATING GHG EMISSIONS

According to Metz et al.,[17] energy efficiency and GHG emissions mitigation in office buildings can be achieved by implementing a three pronged approach namely; reducing energy consumption, deploying low-carbon renewable energy technologies, and lastly monitoring future GHG emissions. The three pronged approach will be highlighted in detail in sections 2.1 – 2.3. In addition the role of government and international organizations through policy enactment and the advocation of sustainability will greatly promote the quest for clean, renewable and sustainable future for environment, mankind and future generations.

A. Reducing energy consumption

It is estimated that lighting, air-conditioning and heating account for about half of global energy consumption in buildings. Hence the general consensus amongst experts around the world is that buildings there needs to be a significant reduction in energy consumption to realistically curb the emission of GHG emissions[10, 18]. This is based on the premise that these end uses of energy in buildings are currently dominated by carbon intensive fuels and electric energy systems derived from petroleum and coal [10, 12]. In the Nigerian context, energy consumption is primarily used for lighting, air-conditioning and sundry services such as operating office machinery and industrial equipment [19]. Consequently, the use of daylighting, natural ventilation and convective cooling as well as the deployment of sustainable design practices and low carbon building materials can significantly reduce energy consumption and GHG emissions. In addition, the integration of sustainable materials such as green paints [11, 20], waste agriculture residues [21, 22], and earth building materials [23, 24] will complement efforts in increasing energy efficiency and reduce their burden on the environment. Furthermore, the deployment of low carbon and energy efficient technologies for lighting, air-conditioning and sundry services can potentially lead to 60 % energy savings equivalent to 700 million tonnes of oil equivalent or 2 Giga tonnes of CO_2 emissions by the year 2050 [9].

B. Renewable (Low-carbon) energy technologies

Low-carbon or Renewable Energy Technologies (RETs) comprise smart innovative systems that generate, store and distribute clean, renewable and sustainable energy. According to the Paris Agreement, the deployment of RETs can potentially limit global warming to 2 °C [18]. Since buildings account for significant consumption of energy globally, the deployment of RETs into buildings can potentially improve energy efficiency, reduce consumption and GHG emissions [9]. In addition, this can be achieved by integrating novel smart technologies like smart metering, energy saving lighting (LEDs), temperature sensors for temperature control, and CO_2 measuring devices into existing buildings [14]. Other commercially available technologies particularly for air conditioning, cooling and temperature control include technologies such as solar thermal, combined heat and power (CHP), and thermal energy storage [9]. The deployment of such technologies into office buildings in Nigeria in the future will require concerted efforts by the building industry, governmental organizations and consumers to ensure low cost, renewable and efficient integration. Many analysts opine this will require significant investments in design, planning as well as R&D demonstration projects. However, the successful implementation and deployment of RETs into Nigerian office buildings will also enhance the overall sustainability of the sector.

C. Monitoring future GHG emissions

The key to reducing energy consumption and ensuring energy efficiency in buildings of the future will be significantly influenced by innovative systems and techniques for monitoring GHG emissions. Consequently, all stakeholders in the quest for global sustainability be required to invest material resources and human capital in the development of innovative systems for gathering comprehensive, reliable and timely data on energy consumption, CO_2 and other GHG emissions.

In addition, analysts posit the collation of buildings emissions data as well as detailed information on building features, technology implementation, energy efficiency and cost/pricing dynamics will aid policy enactment aimed at emissions reduction. Consequently, developing countries like Nigeria urgently require the key players in buildings sectors, academia and government to collaborate on modalities to ensure the realization of GHG and energy consumption reduction strategies.

D. Policy implementation and Sustainability Advocacy

The implementation of sustainable energy policies are vital for the realization of energy efficiency and GHG emissions reduction. Advocacy groups as well as governments around the globe urgently need to improve academic education and mass sensitization on the need for improving energy efficiency. Analysts opine, that the education of building and construction industry professionals such as will help raise standards and guarantee the success of future energy policies. These policies will be vital in overcoming market obstructions and failures in the quest for energy and environmental sustainability. In addition, government backed support and advocacy will help spur technological growth in the energy buildings sector and reduce development and implementation costs. According to the International Energy Agency (IEA), the implementation of future energy policies such as energy performance standards, and programmes such as utility and financial incentives are vital for success in the sector. For developing countries like Nigeria, advocacy and government support for RETs particularly in future smart/energy buildings is imperative. Hence, the government, academia and industry in Nigeria, need to collaborate on key issues relating to energy buildings research, test processes, and market development. Other areas potentially include energy performance standards, GHG emissions reduction targets, as well as harmonizing strategy development. These will effectively reduce costs, hasten technology utilization, and provide quality and performance assurance for future buildings and energy systems.

III. ENERGY POLICIES IN NIGERIA

Energy is considered a key ingredient for socioeconomic growth and sustainable development. Hence the Federal Government of Nigeria (FGN) has over the years instituted several strategic energy policies to guide and direct the development and diffusion conventional as well as renewables in the country. One of the most important of which is the National Energy Policy (NEP) ratified in the year 2003 [25]. The NEP was established to identify, develop and diversify the nation's energy resources with a view to enhancing energy security, investments and development of future energy systems [26].

With the growing importance of RETs, the FGN in 2005 decided to institute the Renewable Energy Master Plan (REMP). The aim of the policy was oversee the visions, targets and roadmap for addressing the nation's energy supply challenges through RETs development [27]. The FGN hopes to that the REMP policy will fast track RETs adoption through the development of renewable portfolio standards, innovative economic and market incentives for growth the industry [26, 28]. Other noteworthy energy policies are the National Energy Master Plan of Nigeria (NEMP), National Policy and Guidelines on Renewable Electricity (NPRE) as well as the National Policy in Environment in Nigeria (NPE).

IV. CONCLUSION

This paper examined smart technologies and strategies for improving the energy efficiency and reducing GHG emissions in office buildings in Nigeria. In addition, the paper also identified strategies for integrating energy efficient as well as zero carbon technologies for lighting, air conditioning and cooling as well as sustainable energy consumption in office buildings in the country. The study reports that energy efficiency and GHG emissions mitigation in office buildings can be achieved by applying the three pronged approach which includes; reducing energy consumption, deploying RETs, and monitoring GHG emissions. In addition, the paper concludes that policy enactment and energy advocacy will stimulate a clean and sustainable future for mankind and its future generations.

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