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APPRAISAL OF RETROFITTING EXISTING STRUCTURES TO PROVIDE ACCESS TO CLEAN AND SUSTAINABLE ENERGY

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ABSTRACT

A pertinent need for sustainable and clean energy cannot be overstated. This is significant to the point that it is listed as one of the sustainable development goals. It is expected that by 2030, there will be universal access to affordable, reliable, and modern energy services. Questions arise when this goal is discussed. Nigeria, as a nation fits into the category of developing nation. The supply of energy falls below the demand and therefore energy provision still poses a major challenge to the populace and even business owners. One of the ways of meeting up with this target is by retrofitting of the existing structures and this is already practiced in developed regions. This paper provides a study of literature to build facts on how the practice of retrofitting can improve the livelihood and standard of living of people thereby making the goal achievable in the target time.

Key word: Sustainable energy provision, clean energy, Demand, and supply.

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1. INTRODUCTION

The United Nations set Sustainable Development Goals (SDGs) to be accomplished by the year 2030. The goals cover areas of sustainability for human development and comfortable existence. These goals range from eradicating poverty and hunger, improving healthcare and education, providing clean water, sanitation, and affordable and clean energy. They also include Checking climate action, reducing inequalities, and improving on gender equality, provision of decent work that fosters economic growth, sustainable cities, and communities etc. However, central in these goals is the provision of affordable and clean energy. Almost all the goals have a relationship with energy provision. A research affirmed that a country's economic and social development is to a large extent energy dependent [1]. It is hard to build, transport, manufacture

or even have smart and sustainable cities without energy. The progress of a nation could be measured by its per capita consumption of energy [2]. The conundrum that is commonly encountered is that even though the field of energy research and development is vast, the methods of harnessing energy that have been employed so far have not been sustainable. Most of the sources of energy that are been utilized are nonrenewable sources such as coal, nuclear, or even fossil fuels. One drawback of generating energy from nonrenewable sources is the fact that most of the nonrenewable sources usually release greenhouse gases (GHG) to the atmosphere that can pave the way for global warming or other climate related problems. It has been desirable to concentrate on the production of energy from sources that are renewable such as hydropower, solar PV, or wind. But the output from hydro and solar or wind is just a fraction of the output from nuclear or even fossil fuels. This is ironic because renewable sources like hydro have the capacity to produce up to six times more than the nonrenewable sources [3]. This indicates that our renewable energy sources are underutilized and underappreciated. Electricity is so important to a nations social and economic development that policies are formed by governments to improve power supply and distribution which will then translate to better standards of living [4]. [5] observed that energy demands are on the rise just as the need for electrical power is on the increase. According to the total energy demand increased from 11,730 million tonnes to 14,121 million tonnes. Of all the primary energy sources which include transportation, heating, cooking, electric power, and others, electricity is the most preferred form of energy because of its convenience of transport and use [6].

1.2. Nigeria's Population and Energy Consumption

Nigeria with a population of over 195 million growing at the rate of 2.61% will get to a situation where the resources will be over stretched and eventually become inadequate [7]. To avoid this imminent resource scarcity, measures must be taken to minimize the rate of consumption of these energy resources. A viable way that the resources can be managed is by employing energy efficient measures in buildings such as practicing green technology to reduce the demand for energy. Nigeria contributes it fair share to the global energy consumption and CO_2 emission and along with the rest of Africa, Nigeria is expected to increase CO2 emission by up to 40% [8]. Another reason it is necessary to practice green building technology is to reduce the demand for electric energy because there is a wide deficit when the demand is compared to the supply. In Nigeria, the demand for electricity is estimated at 16,214 MW against a supply of about 13603 MW which indicates that there is a deficit of – 2,611 MW [9]. This deficit often leads to power outages that are detrimental to the Economy.

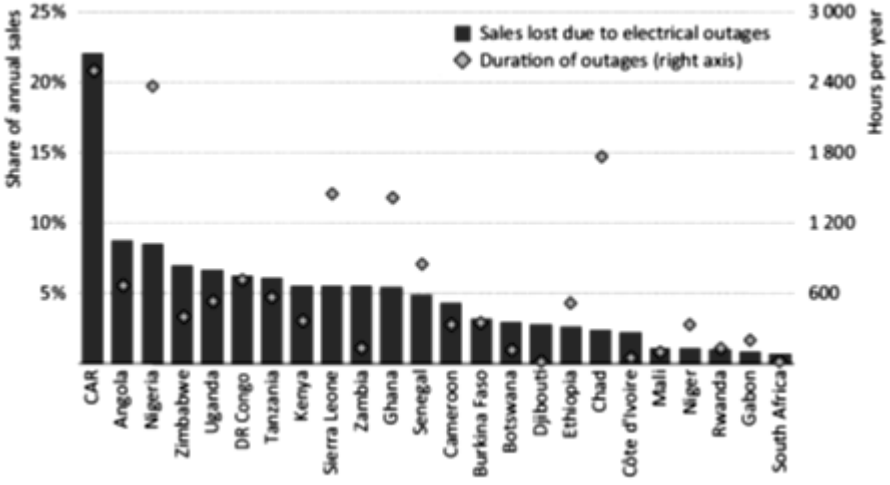

Figure. 1 Annual Duration of electrical outages and impact on business sales in selected countries [10]

In 2014, IEA conducted a survey and published a report on the energy prospects of sub-Saharan Africa. In the report it was indicated that these outages cost the economy of the country affected seriously. These power outages caused disruption of business activities therefore discouraging investments because businesses cannot thrive without adequate power supply. Fig. 1, shows a chart of the annual duration of electrical outages and the corresponding impact on business sales in some selected African countries. From the fig 1. It is seen that Nigeria has power outages a little below 2400 hour a year of electricity outage that translates to about 8% less business sales.

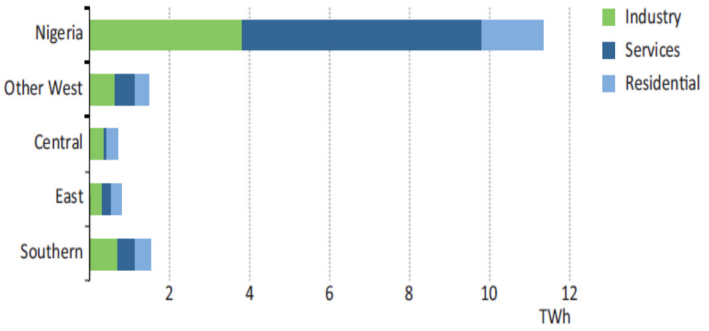

Figure 2 Electricity demand met by back-up generators by sub-region, 2012 Source: [10]

Fig. 2 displays the estimated electricity demand that is met using a backup generator because of the frequent power outages. It shows that Nigeria's dependence on backup generators for industry, services and residential needs exceeds all the other regions combined. This trend is destructive for the environment because these backup generators which in most cases are fossil fuel powered, are a major menace in releasing greenhouse gasses to the atmosphere [11].

A study conducted in Japan by [12] showed that the GHG emission is highest for power generation that is based on Fossil fuels than any other energy source as indicated in fig. 3. From the figure 3, it is important to note that the coal-fired, oil-fired, LNG-fired and LNG-CC fired power plants all fall under the category of fossil fuels power plants. Incidentally, majority of the power plants in Nigeria are fossil fuel fired and even the backup generators use during the power outages are fossil fuel powered.

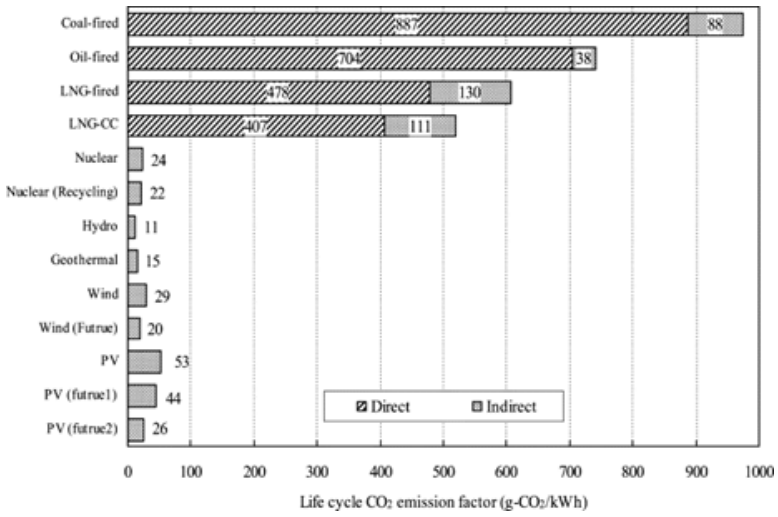

Figure 3. Life cycle CO_2 emission factors for different types of power generation systems. Source: [12]

Power outages are so common that they have become a key point for political campaigns because most of the political candidates vying for office usually promise uninterrupted power supply to the populace. Even the government acknowledges the need for uninterrupted electricity supply and is doing the best it can to ensure that the current power supply increases even though the growing population and rural urban migration will cause the demand for electricity to increase further. One of the ways that the current electricity deficit in the country can be reduced or even eliminated is using sustainable technology in building which are also referred to as green building technology.

1.3. Retrofitting Existing Buildings and Its Challenges

The United States Environmental Protection Agency (US EPA) defines green building as "the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. Green building is also known as a sustainable or high-performance building" [13]. Green building technology does not have to always start from the design of a building alone. An existing building that wasn't initially designed to be green can later be converted to become a green building by retrofitting it with the appropriate technology. However, [14] identified different approaches to retrofitting buildings and pointed out that retrofitting building was more than just providing renewable energy system like solar panels and improving the technological aspects of the building. One part of the retrofitting campaign that is often over looked is the building envelope, which is the relationship between the outside and the inside of the buildings. In most climates of the world, the traditional building produced there usually considered the climatic factors thereby maximizing the building envelope. If the building envelope is to be retrofitted, it will take a large amount of work to be done because altering the building envelope in most cases involves structural work that could affect the stability and integrity of the building in question [15]. Adjusting the building envelope may involve changing the façade of the building and that might entail increasing the openings for the windows or removing entire wall for improved ventilation. Nevertheless, researches have shown that retrofitting existing structures is a good way to achieve green buildings [16- 20]. The benefits for building going green can scarcely be overstated, they can be categorized into social, economic, and environmental benefits. These benefits include better health or wellbeing of the occupants of green buildings, increasing the value of a building that is produced with green technology over traditional building types, reduction in the negative impacts a building has on the environment, reduction in waste generated from the buildings, and reduction in the water and energy consumption of a building [21].

[22] argued that a great amount of energy is wasted due to misuse or abuse of facilities within a building. This waste can be curbed and eliminated with the right amount of retrofit technology employed in the building. For instance, motion sensitive light switches are currently used to control lights when the occupants of rooms leave. This practice saves energy especially when the occupants of a room or an office forget to turn off the lights when they leave the space. If this technology is expanded to not only light switches but also Air conditioners and other electrical appliances, there will be significant energy savings. [23] identified from other literature, 41 barriers to the adoption of green buildings among which are the constraints of existing infrastructure, lack of sustainable energy, unavailable/unreliable sustainable technology/materials, behavior of occupants, insufficient cost-benefit data from interdisciplinary research, inadequate/inefficient fiscal incentives, reluctance to adopt change, etc. These happen to be the key characteristics of the energy sector in Nigeria because Nigeria is still in the infancy stage about green building there is only one building that has been erected

that is certified by LEED. Nigeria just very recently, launched an Energy Efficiency Code that indicates a step in the right direction even though they might seem as baby steps. For many potential practitioners of retrofitting, the major barrier would be the lack of technical knowledge of what it takes to transform an existing building to one fully equipped with sustainable technology. For others it is the prospect of high initial cost that prevents them from attempting to retrofit existing building. While these fears might appear valid, they are short sighted because they do not consider the long term running cost savings that can be enjoyed from a green building [24]. Education, training, and experience remain barriers to implementing green practices in existing buildings. In addition to the education barrier, the cost of certification and paperwork requirements reduce building owner adoption of LEED certification. In a research carried out, it was discovered that green buildings cost between −0.4% to 21% of the cost of conventional buildings [25]. Currently, projects are registered to become LEED certifiable on an individual basis.

2 GREEN BUILDING RETROFITTING RATING SYSTEMS (GBRRS)

The World Green Building (WGB) movement was launched in early 1990 because of global warming and issues of climate change. The world Green Building Council (GBC) is a union of councils from around the world. It primary aim is to fast-track global sustainable building practices. It is the sole authority that appoints and oversees the formation of green building councils throughout the world. It has over 73 members and its affiliated bodies are from nations that collaborate in the adoption and practice of green buildings [26]. These member nations have a form of rating system for their green buildings but the most popular rating system is the LEED which stands for Leadership in Energy and Environmental Design. The UK has the BREEAM (Building Research Establishment Environmental Assessment Method) it's roles are like the LEED but it's policies are more indiegenous to the UK. The same philosophy goes for Australia's GREEN STAR, the south Koreas G-SEED and China's GBL. All these countries have their green building rating system. Despite this popularity, green buildings are not so popular in developing countries. For instance, the first green building in Nigeria was built in 2016 and it was supposedly rated by the LEED system and it was extremely expensive to construct. It cost about $65 million which is more than the conventional buildings of its size. The cost of acquiring the green building certification might have affected the original cost of the building. If Nigeria had its own rating system, perhaps it wouldn't have cost so much to be rated.

3 DEVELOPING A SUSTAINABLE CULTURE AND ENVIRONMENT THROUGH RETROFITTING

Governmental policies are key to making retrofitting practice and sustainable technology a culture. In view of the energy deficit that Nigeria currently experiences, legislations could be made to reward efforts that are deliberately made by owners or builders of structures to erect structures that are energy efficient and sustainable in their production. [27] observed that in Asia, it was common place to find governments advocating the movement to green buildings. This should not be surprising that Asian countries are among the leaders in the practice of green buildings and sustainable technology practices in buildings. Another strategy as pointed out by a researcher is by providing low interest loans and subsidies if they will be used for the construction of a green building [28]. Campaigns can be carried out through adverts to encourage more participation in the green building practice.

A sustainable culture can be developed through the medium of Education. For any culture to be adopted, emphasis needs to be on the training of the younger individuals to encourage them to grow with that mindset. This is usually a long-term activity but it is usually worthwhile

because the culture becomes set in the minds of the young people when they grow practicing it. With that been said, education is key. Sustainability education can make a compound program that incorporates other disciplines and exposes the student to deeper concerns that are ingrained in the SDGs and they grow up as solution providers because of the analytical thinking that sustainability education trains them to do [29]. Sustainability which is central in the practice of retrofitting can be introduced to children as early as in primary school. Primary and secondary school children could be taught about renewable and nonrenewable sources of energy. As they advance, they will easily adopt and even seek to improve on the sustainable practices that they have imbibed in their growth and development. In more advanced institutions of higher learning, it will become easier to introduce more technical and complex practices of sustainable technology because the foundation had already been laid in the early learning periods. Of course, this will involve continuous curriculum development, review, and amendment because of the evolving nature of technology.

Training of skilled workers and professionals will help create awareness and general acceptance of building retrofitting This will encourage more professionals to join the campaign for energy, conservation, because the professional, once trained can engage their new-found knowledge and advice clients of the long-term benefits of retrofitting buildings to be renovated and once the clients experience these benefits, the building retrofitting phenomenon will spread.

4 CONCLUSIONS

Nigeria appears to be far off in the sustainable technology and green building revolution though steps are being taken in the right direction. In 2016, Nigeria completed the very first LEED certified green building and in 2017 Nigeria also released the first ever Energy Efficiency Code to regulate the aspects of green building sustainable technology for the Nigerian context. The government however will have to be on board otherwise the progressive march toward sustainable and clean energy will be slow.

Retrofitting will greatly reduce the GHG emissions and make the buildings energy efficient while reducing the consumption of energy. Hence it should be encouraged. The quest to achieve the sustainable development goal of clean and sustainable energy can only be practicable if there is a structure in place to regulate the laws regarding sustainable or green buildings. The energy deficits currently being experienced in Nigeria will continue unless there is a vigorous campaign for green buildings because green buildings have the capability of reducing the energy consumption of a building while making it energy efficient therefore eliminating that deficit.

Building owners should be sensitized on the benefits of retrofitting because they experience the benefits of retrofitting first hand.

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