

Challenges Facing the Development of Sustainable Petrol Filling Stations in Minna, Niger State, Nigeria

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Abstract

The issue of Global warming responsible for climate change effects has become a topic of debate all over the world today. Buildings and fossil fuel emits carbon monoxide (CO₂) into the atmosphere which also contributes to climate change. The activities of Filling Stations has made them major contributors to land, water and air pollution. Petrol, kerosene, gas, oil lubricants and diesel which constitute high carbon monoxide (CO₂) and other chemical compounds can result to health complications after long time exposure. The application of sustainability principles in the design and construction of Filling Stations can help to reduce its negative impact on the environment. Reviewed literature on sustainability highlighted some of the challenges encountered by Architects and project managers in the implementation of sustainability requirements in the construction industry which includes lack of knowledge on sustainability, high cost of sustainable building materials and Technical know-how among others. This study therefore assesses the barriers encountered by Architects and building developers in the development of sustainable Filling Stations with a view to encourage the existence of eco-friendly Filling Stations in Minna, Niger State- Nigeria. A total of 50 Filling Stations were selected for the observation of their design and construction features. The data obtained was presented with the use of plates and figures to buttress physical descriptions. Some of the findings from the study revealed 48% of Filling Stations lacks adequate land size to incorporate sustainability features, 66% of Filling Stations made use of concrete as preferred building material due to the affordability and easy workmanship, influence of design by client and lack of maintenance plan in more than 75% of Filling Stations are some of the challenges encountered in the design and construction of sustainable petrol Stations. Recommendations were made for Architects and related professionals to acquire more knowledge on sustainability, while Nigerian Government should create more awareness on the importance of sustainability. Finally, government needs to revamp the existing laws in the construction industry and as well establish new laws if need be in order to facilitate the implementation of sustainability in the built form in Nigeria.

Keywords: Architects, buildings, ecofriendly, filling stations, sustainability

Introduction

The pressure from rapidly increasing world population, the over exertion of human needs and wants on the available natural resources is damaging the environment and threatening human existence (David, Huang, Cordova & Pimentel, n.d). The world is continuously being polluted by degradation of the ozone layer through the release of gases such as chlorofluorocarbons, and the burning of

fossil fuels, coal, diesel and other oil & gases which is changing the natural climate of the earth (Ohio Environmental Protection Agency, 2011). The change in global climate directly affects rise in temperature and sea levels, which results in flooding, desertification, and other environmental damages. In a recently published study by the proceedings of the National Academy of Sciences, researchers predicted more extreme heat in the environment resulting

from erratic climatic variations (Global Guardian News Paper, 2017). They further alerted that over 350 million people living in big cities will be affected by extreme heat yearly. Previous and subsequent studies on impacts on health of climate extreme carried out by the World Health Organization (WHO) (2003) in Australia has also proven that high temperature and humidity is dangerous to man especially children, infants and those with existing health challenges, coastal residents and those living in poorly located settlements (Global Guardian News Paper, 2017).

Filling Station is a public facility where fuel and other lubricants are sold for motor vehicles (Olugen, Olajide, & Sunday, 2011). Most Filling Stations in Nigeria are located along major roads to maximize accessibility and marketability, which also means they could be close to some public, commercial and even residential areas. This contravenes the regulations for the siting of Filling Stations (DPR, 2007). Inhalation of benzene can result to irritation of the mucous membrane, cancer of the lungs, stomach leukemia, and aplasia, heart attack and bone marrow depression (Hunter, 1966). Similar studies carried out by Brugnone, Perbellini, Romeo, Bianchin, Tonello, Pianalto, Zambon, and Zanon (1998) further revealed that Filling Station attendants and car mechanics that are exposed to benzene for a long time are liable to series of respiratory health challenges. This has made it necessary to explore safety measures to mitigate these negative effects from the planning and design perspectives (Sangotola, Fasanmade, Ayanrinde, Olatinwo, Olaniran, 2015).

In many developing countries today, authorities and oil marketers are adopting modern sustainable technologies especially in the area of waste generation to reduce the negative effects of oil handling in the environment (Georgi, n.d). This paper therefore, seeks to examine the challenges facing the development of sustainable Filling Stations in Minna Niger State, it also highlighted some measures that can be adopted in order to break barriers so as to

mitigate the effects of climate change through design and construction of environmentally friendly Filling Stations.

Overview of Filling Stations—in Nigeria

Nigeria is one of the largest consumers of fuel and other oil products in Africa with about 40 million liters consumed daily (Kunle, 2015). This is because of the large number of cars plying the roads and the epileptic power supply in the country, which makes almost every home, shops, banks and restaurant owners operate generators powered with petrol or diesel (Darlington, 2016). According to (Udoh, 2013), the existence of Filling Stations in Nigeria began in 1907 when Soconomy vacuum oil company which is now known as Mobil Oil Nigeria Limited began marketing Sunflower Kerosene in Lagos, Enugu, Kaduna and Ibadan. Up until independence in 1960, oil marketers were responsible for sourcing their own petroleum products and after independence, there was an increase in transport infrastructure development which saw better roads networks across the country. These significantly increased the demand for fuel and other petroleum products. Udoh 2013, further opined that the increasing demand of petroleum product in the post-independence era is responsible for the upsurge of more Filling stations in Nigeria. The petroleum industry is made up of the upstream sector which deals with exploration, evaluation, assessments development, decommissioning and the downstream sector which deals with distribution of refined petroleum and retailing (Darlington, 2016). Major oil Marketers are involved in all stages of the oil and gas, and most of them operate under brand names like TEXACO, Mobil, AP, Oando, and Total. They also enjoy all the benefits therein, while an independent marketer sources for his products and operate under a chosen name (Darlington, 2016).

There are basic requirements for the siting and construction of Filling Stations in Nigeria. They include location, land area

and type of design for proposed Filling Station. The department of Petroleum Regulations (DPR) is a federal agency responsible for the regulations of Filling Stations activity in the country while the respective state development control boards are responsible for granting approval for location and construction, in Niger State, it is the Urban Development Board (UNDB). Despite these regulations put in place by these agencies to check their activities, indiscriminate siting of Filling Stations in contravention of the extant rules has continued to be a source of concern. Ujjwal and Sokhi (2006) opined that Filling Stations are one of the contributors to traffic hazard, non-aesthetics and are liable to fire outbreak. The summarized guidelines for planning and operation of Filling stations in Nigeria according DPR (2007) are:

- a. Land must be zoned for commercial/industrial use
- b. Land area for filling station should not be less than 30x30m
- c. There should be minimum of 400metres in between 2 Filling stations
- d. A minimum of 50m should be maintained in all directions of Filling Stations to other buildings to serve as protection zone.
- e. Number of Filling Stations to be located along 2km radius of site should not be above 4
- f. Minimum distance from fuel pump to the center of the road is 15m
- g. A minimum of 100m should be maintained between Filling Stations and public facilities
- h. Site for proposed Filling Station should not encroach with NNPC/PPMC pipeline, rail lines, electric power lines or cables. (Procedure guide for grant of approvals to construct and operate a petrol products retail outlet by DPR, 2007).

i. Just as with many planning guide for building construction in Nigeria, the issues of environmental friendliness and challenges are not included in the planning guide by the regulatory bodies. And this is believed to be responsible for the lack of awareness of sustainability assessment by

the developer, operator and regulator of filling stations in Nigeria.

Environmental Impacts of Petroleum Products Retailing

According to the world Health Organization (WHO, 2010) urban development contributed to the increase in number of petrol stations across the world. This has further endangered the health and life of people living within the vicinity due to constant traffic and exposure to harmful vapor emissions (United Nations, 2010). Most Filling Stations sell petrol (PMS), liquefied Natural Gas (LNG) diesel and kerosene (AGO). There are volatile organic compounds (VOC) present in these fuels especially petrol which contains benzene that makes it emits vapor even in the lowest temperature and it is highly flammable. This means, it is like a time bomb that can explode or catch fire at the slightest accident. Also, when it gets into water, it can float and travel long distances and cause harm to human and aquatic life away from their actual location (Menkes and Fawcett, 1997). According to National Fire Protection Association (2010), fire and explosions in service stations were projected at 7400 between 1994 and 1998. Some of the problems associated with existence of Filling Stations anywhere include; Fire Outbreak, road accident, traffic congestion, hazardous substances, electricity, security challenges, and pollution. The negative environmental impacts of the existence of filling stations can be reduced to the minimum by adopting sustainable control measures in the design and construction stage (National Fire Protection Association, 2010). Architects have come to a collective agreement that decisions and actions to reduce existence of CO₂ gas emissions by 80% from the environment is key to climate change effect by the year 2050 (Royal Institute of British Architects RIBA, 2012). Architects can make positive impact on effects of climate change through design and specifications of sustainable buildings. Though, seeking sustainability has brought series of challenges to Architects, this ranges from lack of awareness on sustainability

principles, sustainability requirements of specific buildings, client request, and public responsiveness to sustainability and pressure to conform to professional ethics (Adedeji, Toyin and Damilola, 2012).

Challenges Facing the Sustainable Development of Filling Stations

Sustainable construction is derived from the concept of sustainable development applied to the construction sector. As defined by Kibert (1994), it is the creation of an accountable and healthy built environment based on cautious management and resourceful ecological principles. One of the most significant long-term impacts of sustainability is the ability for future generations to have the same resources and opportunities for the development that we enjoy today. There is little on literature regards sustainability and Filling Stations. Arif, Egbu, Haleem, Kulonda, & Khalfan, (2009) listed some of the challenges of developing sustainable buildings to include: limited knowledge on sustainability, Lack of finance, effect of culture and value, technology deficiency, and lack of sufficient research on sustainability, and financial constraints. Similarly, Dania, Kehinde, and Bala (2007) concluded that practicing professionals in the Nigerian construction industry are not aware of sustainability. These factors also relate to the development of filling stations in Nigeria.

On the other hand, with the spate of rapid urbanization and acceleration of construction activities in most developing countries, Du Plessis (2007) advocated for deliberate efforts to prevent the needless negative impacts of building construction activities by totally embracing the sustainability agenda. Despite this advocacy, evidence from the literature highlights limited progress in this regard in developing countries. One typical example can be found in Nigeria where, as in other developing countries, the construction sector is crucial and a leading driver of economic development (Zuofa, Ochieng, & Burns, 2015).

When put together, these barriers and challenges raises concern about the state of sustainability within the construction industry in Nigeria. As demonstrated from the reviewed literature, even with the higher level of advancements in developed countries, certain barriers affecting sustainability in construction were identified and these perhaps is more serious in developing countries such as Nigeria (Zuofa, and Ochieng, 2016). All these means that sustainability among construction industry stakeholders needs to be examined and reviewed. Having reflected on the concept of sustainability within the construction industry and its current challenges, this study attempt to investigate the barriers to development of sustainable design and construction of Filling Stations in Minna Niger State.

Materials and Methods

An extensive literature review was carried out to have a broad understanding of sustainability and how it relates to the petroleum industry and construction industry. The study was carried out to cover sustainability principles in the petroleum sector and the challenges encountered in the development of a sustainable Filling Stations in Nigeria. The descriptive research method was adopted for the study (meaning what and what) with a post occupancy evaluation approach. The study area is Minna- metropolis, Niger State, covering Bosso and Chanchaga Local Government Areas. From the reconnaissance survey conducted, there are a total of 78 Filling stations in the study area from which 50 Filling Stations with not less than 4 petrol pumps (8 nozzles) were purposively selected. Furthermore, a checklist was prepared to elicit information on those requirements that should be available in order to achieve eco friendliness in Filling Stations. This was in order to gather information on availability of sustainable features and the challenges associated with its planning and development. Some of the variables listed in the checklist include: Location, size of land, choice of building materials, waste management technique, alternative source of power supply and post

maintenance Plan. The Filling Stations were grouped into 3 according to location, while research assistants were employed and allocated to each group. The information gathered was transferred into SPSS software where cross tabulations and tables of frequency were used to analyze the data. The result obtained from the SPSS was imported to Microsoft excel where tables and charts were generated for the study. The presentation of pictures in this study was done with cameras and the result was presented as plates to buttress some of the explanations. The discussion of result were presented in subheadings that suit the subject matter examined in order to achieve the purpose of the study.

Results and Discussions

The results in Table 1 shows the land area occupied by Filling Stations in Minna, Niger State. About 5 Filling Stations representing 10% of the filling station in Minna metropolis occupy a plot size of 15x15m, 19 which is 38% of total Filling stations have plot size of 15x30m, 14 (28%) Filling Stations occupy a plot of 30x30m, 4 which is (8%) of Filling Stations are situated on a plot of 40x60m, while 2 (4%) have plot size of 50x100m, while 6 (12%) Filling Stations have a plot of 60x100. This findings have revealed that about 24 Filling stations representing 48% of the sample population are located on a land area below minimum requirement. Only 14 Filling stations representing 28% of the sample size met the minimum requirement of 30x30m while 12 Filling Stations with total of 24% possess land area above minimum requirement.

According to the State Urban Development Board, area for Filling Station should not be less than 30x30m which corresponds to 2 plots of land. Majority of Filling Stations in Minna engage in other businesses aside from their primary function of selling Fuel. But there must be adequate land provision in order to conveniently provide for other supporting facilities in the Filling Stations and also make room available to include sustainability features such as soft landscaping. Furthermore, findings revealed

that all the Filling Stations visited are located along major roads in Minna metropolis. There is a seeming competition among oil marketers, and that account for why all want their Filling Stations to be located along major roads and Central Business Districts (CBD) of the town. But due to the existing law by the State Government to build only high-rise buildings along major roads in Minna, there is pressure on land availability within these locations. Therefore, existing Filling Station owners do not want to relocate for fear of low market while new Filling station owners still prefer to source and access the small lands available along major roads and business activity areas than to locate their Filling Station in other parts of town where there are available lands that can accommodate more facilities and enhance assessment of sustainable design considerations to achieve eco-friendliness. A result of this study agrees with the work of Abdullahi and Adedayo (2017), which shows that despite most Filling Stations having minimum land sizes of 30x30m and 15x15m, they still squeeze in several functional spaces all in the bid to make more profit which is an unsustainable practice. Though this would not have been the case if the DPR ensured that its EIA requirement is strictly enforced.

Furthermore, the location of these Filling Stations violate the DPR guideline for location of Filling stations which specifies that minimum distance of Filling stations to schools, market and other public buildings to maintain 50m in all directions (DPR, 2007). As shown in plate I, First El-Shaddai Filling Station shares boundary with another Filling Station and a market. The land size is inadequate with no form of sustainable feature present. According to Mohammed, Musa and Jeb (2014), guiding rules and regulations should be followed rather than client discretion in the location of Filling stations. However, that is not the case as all Filling Stations observed in the study area are either located close to schools, mosque and other public facilities or sharing border with residential areas. The consequences of oil spills and leakage from Filling Station

can lead to fire outbreak, water and land pollution which can cause serious harm to human and aquatic life in the metropolis.

Choice of Building Materials in Filling Stations

The Architect is responsible for the choice of building materials as specifications which is included in the working drawings. Results in figure 1 indicated that the most preferred building material is concrete amounting to 33% of Filling Stations, 33% accounted for concrete and steel frames, strictly used in Fuel dispensing area. Only 3% of the Filling Stations in the study area used bricks but only for aesthetic purpose, while 12% made use of plastic for roof covering in the entrance porches. The most preferred construction material in Filling stations observed is concrete amounting to a total of 66%. This is because it is relatively cheaper and easier to handle though it is not classified as a green building material. The processes of concrete manufacture and use emits CO₂ into the atmosphere which contributes to climate change. Also, concrete is heavy and not flexible to mould into different shapes, and contributes to general heat gain in the building.

Sustainable designs are mostly easy to construct and flexible to maximize space and also ease maintenance. This is the reason why modern technological buildings are using canopy structures, tent structures, and frame work construction method of building to maximize the advantage of flexible installation including other mechanical fixtures and for easy dismantling when the need arises. Steel is highly sustainable and flexible to work with. But due to challenges of easy accessibility, technical support and high cost of acquiring high quality steel material, many Filling Stations have limited its use to areas of importance such as roofing, columns and beams that carry the weight of the structure especially in the fuel dispensing area which is deemed to be most important and busy place in the Filling Station. The use of bricks and plastic which are the most used sustainable building material today is very rare, and also restricted to less important areas in the station. Bricks and plastic are highly resistance to fire, easy to handle, reusable and aesthetically pleasing because it requires no any other finishing. They are also expensive, and scarcely available for large scale projects.

Table 1: Availability of Land for Filling Stations in Minna Niger State

Plot Size	No. of Filling Station	Percentage %
15x15m	5	10
15x30m	19	38
30x30m	14	28
40x60m	4	8
50x100m	2	4
above 60x100	6	12
Total	50	100



Plate I: A. A. Erena Filling Station
Has large land size but has converted some part



Plate II; First El-Shaddai Nig. Ltd shares boundary with
another Filling Station and market For farming

In figure 2, 70% of total Filling Stations observed made use of Aluminium as roofing sheet, 22% made use of Zinc roofing sheet and 8% step tiles roofing sheet. The fuel dispensing areas in Filling Stations are busy business areas that are prone to Fire, hence roofing material in Filling Stations should be highly fire resistant and should span long distances. There is no Filling Station that adopted the use of green roof. Green roofs are used to reduce rain water runoffs and to serve as means of natural cooling in buildings. They also beautify spaces and reduce water pollution, as water that is supposed to pour on the floor will be used to water green. But the roofing materials that are highly fire resistant such as steel, flat roof (covered with green) and canopy structures are expensive to install especially for large scale products including regular maintenance cost. Many clients will decline to use such roofing materials and techniques that would cost a lot and will prefer to access the readily available ones that are also

cheaper to install and requires little to no maintenance. Geoff B. (n.d), suggested that the initial cost of the building may only make up 20%-30% of the total building cost over its useful life span. He went further to explain that the concept of entire lifecycle cost of a building is yet to be fully understood, but initially expensive buildings often times eliminate the need for frequent short time modifications that may cost the client more. Tent and canopy structures are recommended for use in Filling Stations because it can span long distances, admit ample amount of light into space which could also be maximized for solar panels, they come in different shapes and sizes, and also highly resistance to Fire. The challenges of accessibility, cost of sustainable building materials, high cost of installation and maintenance cost is responsible for less frequent use of sustainable roofing materials in Filling Stations.

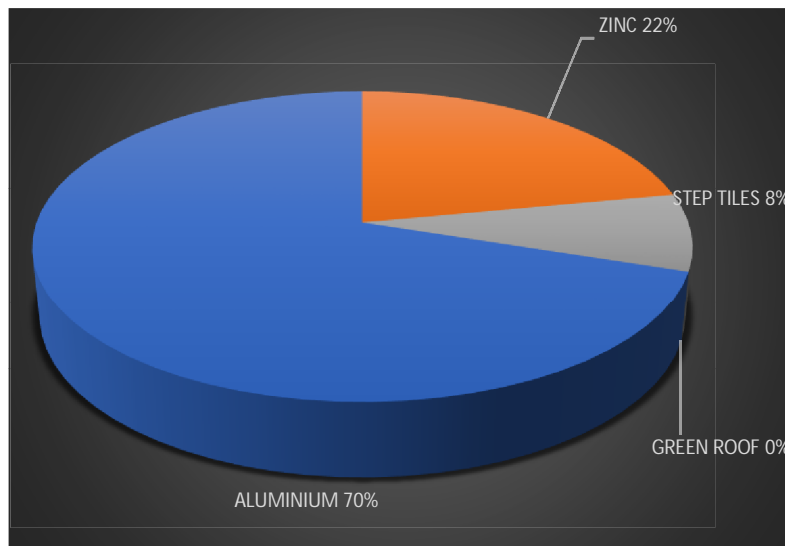


Figure 1: Type of roofing material in Filling Stations Minna

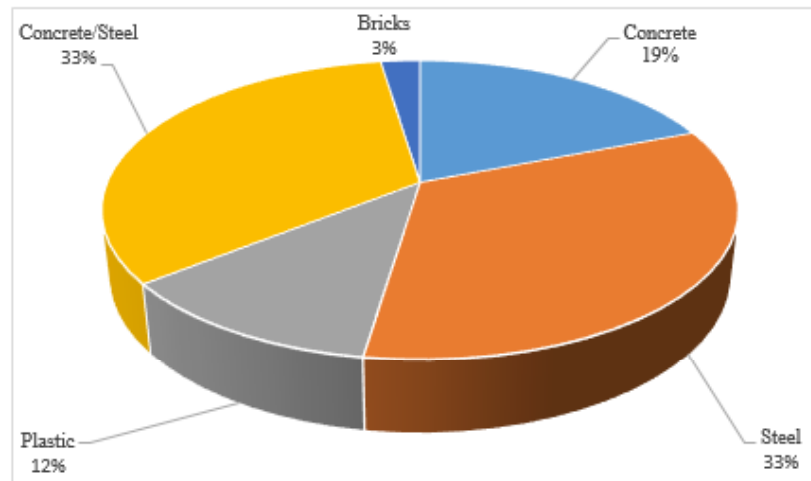


Figure 2: Preferred building material in Filling Stations Minna

Efficient Water Supply and Management in Filling Stations Minna

Filling Stations just like every other facility require water for domestic use in the retail facilities and for maintaining green vegetation. There is an inconsistent to no supply of pipe bone water in many areas in Minna, the reason why few have resulted to alternative sources such as well water and boreholes. Sustainable water use in building construction collects rain water which is used to water plantings and may be treated for other hygienic use. Result in Figure 4 reveals collection and use of rain water in Filling Stations, which is through the manual process of collecting water in a tank through the edges of the roof and fetching with a bucket. About 14% of the Filling Stations observed use rain water for toilet Flushing, only 4% use rain water for green areas and farmlands which of course is an unsustainable practise in a Filling Station. But this process is tedious because it is manually operated and it is not serving the intended purpose.

In addition, assessing Grey water harvest and recycle system requires the expertise of a professional that has a sound understanding of the Grey water recycle machine that may be suitable and efficient for the Filling Station, the number of tanks required to collect, store and recycle water sufficient to run the Filling Stations and the best place of location. Most importantly, rain water do not last throughout the year, therefore water from car wash area and other places of high water use in the Filling Station have to be collected and recycled continuously to ensure steady supply throughout the year. But this system, design and fitting is expensive to install. Some clients will feel reluctant to provide for this system because they may feel the occupants may not be able to pay better rent despite this extra efficient water feature provided. According to Geoff B.(n.d), a building developer may not be encouraged to pay for additional green features included in a building because the buyers or tenants may be ignorant of the benefits that are associated with and may decline to pay higher amounts.

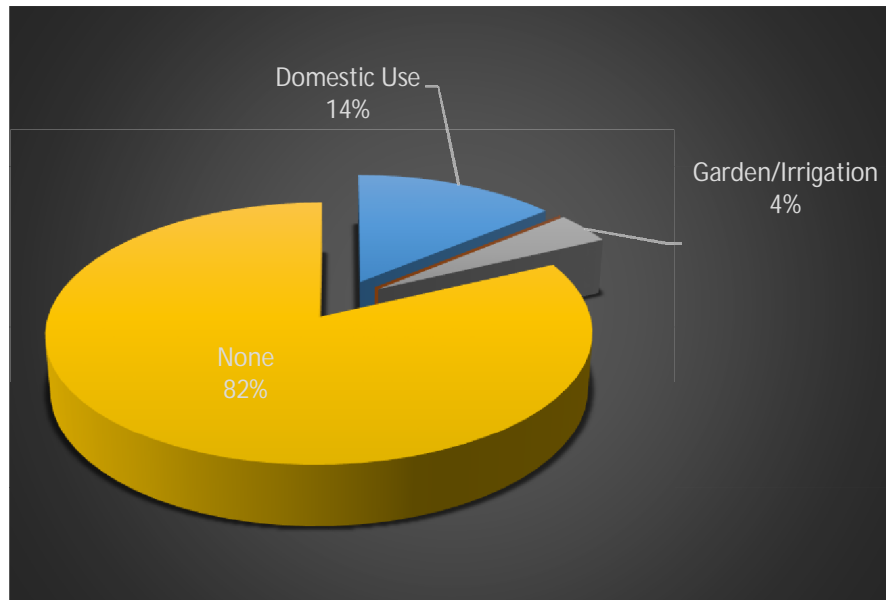


Figure 3: Use of collected Grey Water in Filling Stations Minna

Alternative Energy Source in Filling Stations Minna, Niger State

Electricity is an important requirement in Filling Stations to run its services, but Nigeria is still struggling to supply efficient power supply to its citizens. Virtually all Filling Stations observed have generator as alternative to electricity supply. In figure 3, the main source of power supply is electricity and only 1 Filling Station had photovoltaic system to power a small retail area which was installed without the solar panels reducing its efficiency. Nigeria is blessed with ample amount of sunlight that can be maximized to power as much power as required. But some of the challenges that impede the use of photovoltaic system is the cost of Installation. They have become quite popular in many Nigerian homes and it costs fairly high to install a good and long-lasting photovoltaic system. As opined by Geoff B. (n.d), a building developer may not want to pay for cost of additional green features such as solar panels when the benefits will be enjoyed by the tenant or new buyer whom will not necessarily want to reimburse for additional benefits. Filling Station is a busy facility with activity areas

which include the fuel dispensing area, retail areas, in some cases plaza, service and car wash areas. To install a photovoltaic system to power the fuel pumps and other electrical appliances efficiently will cost a lot for initial capital and subsequent maintenance cost.

Furthermore, the design and roof span of most Filling Stations observed is not adequate to accommodate as much solar panels as may be required to power the facility. This is where the type of building plan and choice of roofing materials play important role as many Architects design without consideration for such provisions in the present or future. Instead, they simply make provision for generator houses to run generator sets which emits harmful toxics that are major causes of air pollution. Building developers must begin to see the importance of sustainable means of power generation in Filling Stations by breaking barriers to ensure their availability for efficient running of business activities and also to save overall running cost while being environmental conscious (Abdullahi and Adedayo 2017).

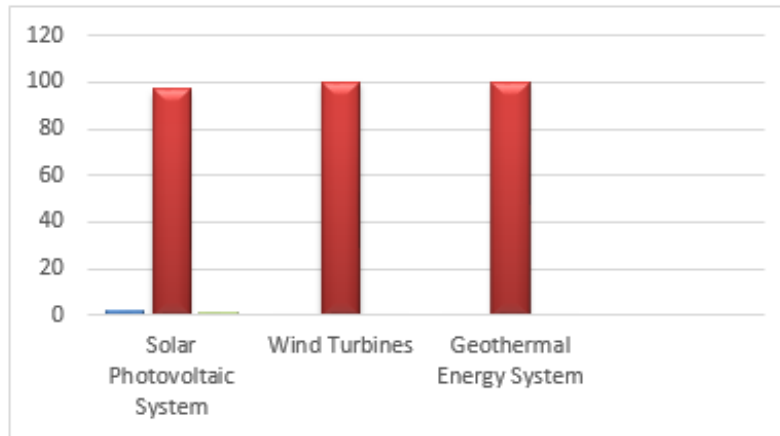


Figure 4: Alternative Source of Energy

Conclusion and Recommendations

Sustainability requirements that can be included in Filling Stations include: sustainable planning (zoning of activity area), use of fire resistant materials such as Polytetrafluoroethylene (PTFE), tent and canopy structures, plastic, bricks and landscape feature. Generally, it can be concluded that barriers to sustainable Filling Stations planning and development in Minna is due to social, economic and environmental factors. Increase urbanization and rapid infrastructural development in countries such as Nigeria has made it necessary to adopt sustainable construction principles in order to achieve sustainable development (Du Plessis, 2007). Client's decision may differ on sustainability provisions, where a client with a vast knowledge and experience on sustainability will be willing to include such features despite the cost whereas another client may see it as unnecessary. The findings from this study concludes that the barriers to sustainability in Filling Stations include; lack of knowledge on sustainability, lack of integration of sustainability features in the design stage by Architects, influence of design by clients, high cost of sustainable building materials, lack of technical manpower, and absence of subsequent maintenance plan. There is need for the stakeholders in the construction industry to create awareness on the importance of sustainability. As pointed out by (Hartshorn et al., 2005; Graedel & Klee; 2002) on the barriers to sustainability, the

term has not been fully embraced by stakeholders in the construction industry. It is very important for architects' and other building professionals to gain adequate knowledge on theories as well as practical implementation of sustainability in the built environment. Also, Federal Government and policy makers should show positive attitude towards environmental sustainability, review the existing legislation in the construction industry and implement new laws which will encourage sustainability practice in Nigeria.

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