Factors Inhibiting Energy Access in the Delivery of Construction Projects in Lagos Metropolis, Nigeria

**Abstract**
Energy plays a vital role in all human endeavours. However, access to energy globally is limited, and concerted efforts are being made to bridge this gap. Little empirical works exist on the energy situation in the delivery of construction and infrastructure projects in Nigeria. The specific objectives of this study assessed the level of access to energy sources, factors inhibiting energy access, and benefits of energy access for the delivery of construction projects. Data reported in this paper were collected through a quantitative research approach whereby copies of the questionnaire were administered to small, medium, and large-sized construction firms in Lagos metropolis, Nigeria. This study's findings revealed that the most accessible energy source for construction activities in Lagos Metropolis is automotive gas oil (diesel). Furthermore, the study established that factors inhibiting access to energy for the delivery of construction projects are efficient supply and distribution, government regulation, and inadequate infrastructure. The paper concludes that access to energy for construction works in Nigeria is inadequate due to poor implementation of government policies on energy provision. The paper recommends creating new strategies to implement policies to improve access to energy in Nigeria.

**Keywords:** energy access, inhibiting factors, construction project, project delivery, Lagos Metropolis

## 1.0 Introduction

Energy is the power generated when physical or chemical resources are utilised to provide light, heat, or work machines. Energy access is the fulcrum to achieving many development goals, such as poverty eradication, clean water provision, food production, access to public health and education, women empowerment, and economic opportunity. Most times, especially in the contemporary world, development is impossible without energy, and sustainable development is impossible without sustainable energy (Ki-moon 2011). Access to energy is a symbol of civilisation, instrumental for economic activities, and contributes to sustainable communities' overall health and well-being (Chaurey and Kandpal 2010). One thing is for energy to be available, and another is for energy to be accessible. Energy is not useful until it is accessible.

Sub-Saharan Africa is the region of Africa located south of the Sahara desert, and it includes a diverse range of countries with different cultural and socio-economic backgrounds. Sub-

Saharan Africa has been plagued with a significant challenge of energy access. According to the World Bank Global Electrification Database, the electrification rate in the region is very low compared to other parts of the world, with only 48.2% of the population having access to electricity as of 2020 (Figure 1). The number of people without access to electricity in Sub-Saharan Africa rose to 610 million in 2013 before declining to roughly 595 million in 2018. About half of the population in sub-Saharan African countries live without access to electricity, especially in five countries like Nigeria, DR Congo, Ethiopia, Tanzania, and Uganda (International Energy Agency (IEA) 2019b). Surprisingly, Nigeria is a country that is blessed with abundant energy resources, including solar, wind, biomass, crude oil, natural gas, and coal, yet an estimated number 60-70% of the Nigerian population lives without access to electricity (Oyedepo 2012). Despite the enormous energy resources available, Nigeria's energy poverty level is alarming (Eleri et al. 2012).

Despite the low level of energy access, Oyedepo (2012) affirmed that energy needs in Nigeria continue to rise due to the increasing population without sufficient energy development programs to bridge the energy access gap. The present energy policy in Nigeria is yet to meet the demands. It is driven by urban-centred needs, thus neglecting rural and sub-rural energy demands. This shows that the energy supply in Nigeria has been primarily to cities, political territories, and curious places of industrialisation, resulting in energy imbalance across Nigeria's socio-economic classes. While further affirming the low level of energy access, Ajayi and Ajanaku (2009) affirmed that the ever-increasing population has incapacitated Nigeria in meeting the energy needs of the Nigerian populace.

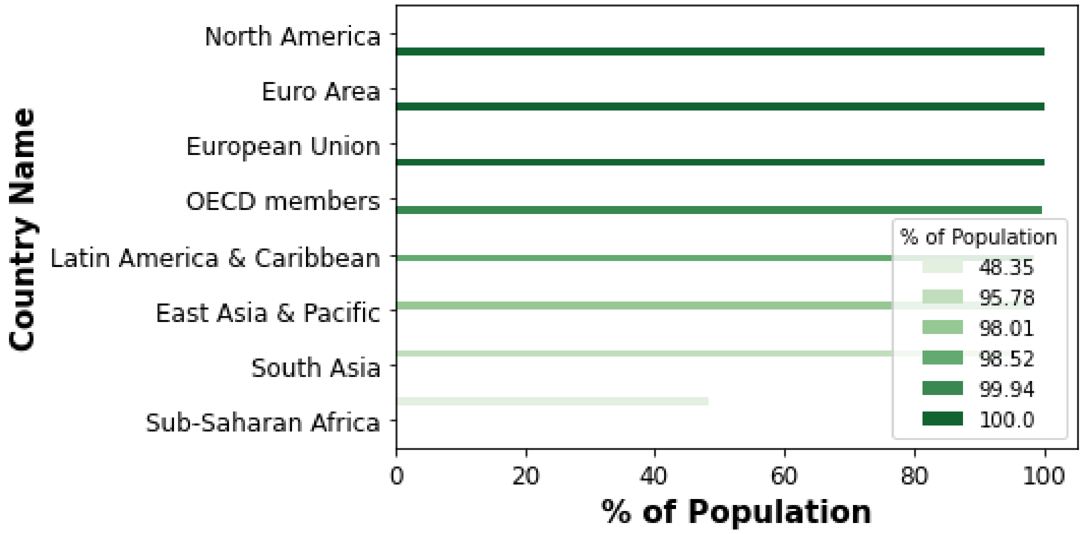


*Figure 1: Electricity Access in sub-Saharan Africa and other parts of the world*

Note. The data is from World Bank Global Electrification Database from "Tracking SDG 7: The Energy Progress Report", by The World Bank Group, 2023 (https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS). Copyright 2023 by The World Bank Group

The construction industry is one of the largest consumers of renewable and non-renewable resources (Horvath 2004; Holtzhausen 2007; Dixit et al. 2010a). It depletes 40% of global energy annually. Approximately two-fifths of the global raw stone, sand, and gravel supply and one-fourth of the world's total virgin wood supply is consumed in construction activities (Ding 2004; Langston and Langston 2008a; Dixit et al. 2010b). According to Kedar et al. (2011), the operation of buildings accounts for 25% to 40% of the total final energy used. The energy is consumed directly or indirectly either in a primary (natural gas or oil) or secondary (electricity) form (Marszal et al. 2010; Dixit et al. 2013). The environmental impacts of energy consumption in building construction are imposed during the whole life cycle of a building (Hendrickson and Horvath 2000; Sharrard et al. 2007).

Previous reports have consistently highlighted the issue of energy poverty in sub-Saharan Africa, focusing on Nigeria as a critical representation in the region. Notably, the International Energy Agency (IEA) has issued several reports on the global energy situation, including in 2011, 2014, 2015, 2017, and 2019a, addressing this issue. Additionally, the Energy Sector

Management Assistance Program (ESMAP) released a report in 2015 on this topic. In the context of sub-Saharan Africa, researchers such as Abeeku (2010), Aliyu et al. (2013), Osueke and Ezugwu (2011), IEA (2019b), Power Africa (2018), Ugwoke et al. (2020), and Uzoma and Amadi (2019) have also contributed to the discourse on energy poverty.

Furthermore, prior empirical studies have primarily focused on the embodied energy, energy consumption, and environmental impacts of buildings, with limited attention given to energy access during the delivery of construction projects (Dixit et al. 2010a; Dixit et al. 2013; Hegner 2007; Holtzhausen 2007; Langston and Langston 2008a; Langston and Langston 2008b; Marszal et al. 2010). Only one study by Treloar et al. (2004) has examined energy access related to the extraction, production, and transportation of construction materials but did not address on-site construction processes. As a result, there is a gap in the literature regarding empirical studies on energy access during the delivery of construction projects, which this study aims to address.

This study focuses on access to secondary energy sources, which are delivered energy to end-users, such as electricity, liquified petroleum gas, premium motor spirit, and automotive gas oil. Hence, the study examines the construction industry's level of access to energy, factors inhibiting energy access for construction activities, and the benefits of energy access in the delivery of construction projects in Lagos Metropolis, Nigeria. Energy access in this paper refers to a situation whereby construction companies can access and use energy when required in their operations while delivering construction and infrastructure projects. The findings of this study will contribute to the body of knowledge as one of the earliest studies on energy access in the construction industry. Additionally, it exposes the factors inhibiting energy access, and recommendations are made to combat them. The outline of this paper includes background to the problem, a review of literature, methodology, results, discussion of findings, and a conclusion including areas for future research.

## 2.0 Energy Consumption in the Construction Industry

An energy source is any resource from which usable energy can be extracted. Osueke and Ezugwu (2011) classified Nigeria's energy resources as renewable and non-renewable. Renewable energy sources can be replenished or produced quickly through natural processes (Texas Renewable Energy Industries Alliance (TREIA) 2015). They include solar energy, wind, photochemical, thermal, hydropower, geothermal, photoelectric, tidal wave, and bioenergy (Aydin 2010). Non-renewable energy resources cannot be generated, produced, or used on a scale that can sustain their consumption rate because they are consumed faster than nature can create them.

In a report by the Canadian Architect (2010), energy consumption in the construction industry is divided into operational energy, embodied energy, and decommissioning energy. Operational energy is used for heating, cooling, ventilation, lighting, equipment, and appliances (Dixit et al. 2010b; Dixit et al. 2013; Langston and Langston 2008b). Embodied energy is any energy consumed in the extraction and manufacturing of construction materials, including any transportation related to these activities. Additionally, embodied energy includes energy used up in transporting construction materials to the site, constructing the structure, and maintaining, repairing, or replacing materials, components, or systems during the life of a structure (Langston and Langston 2007a). The embodied energy of buildings differs with the type of masonry material used and mortar used for jointing and rendering (Effiness et al. 2016). Finally, decommissioning energy is required to demolish the building and transport the demolished materials to landfill or recycling centres.

Talukhaba et al. (2013) identified diesel, electricity, petrol, and gas as the energy sources commonly used in construction activities. However, our review of the literature revealed a more comprehensive range of energy sources available for the delivery of construction projects, including automotive gas oil (diesel), premium motor spirit (petrol), hydropower, liquefied petroleum gas, solar, nuclear energy, coal, biomass, and wind. These energy sources can be classified into two categories: renewable and non-renewable. Non-renewable sources such as diesel and petrol are considered traditional energy sources, and their generation and availability depend on the location of the resources. Conversely, renewable energy sources like solar and wind are not limited by location but depend on the specific nation or region's energy demands, driving factors, and policies. Unfortunately, limited information on energy sources in Nigeria's construction industry is available.

## 2.1 Situation on Energy Access

Energy access is a state where households have unrestricted access to affordable and dependable energy supplies (Karanja *et al.* 2017). In agreement, IEA (2011) submitted that universal energy access means a household has dependable and economic access to clean cooking facilities, the first electrical connection, and then increasing power usage over time to reach the regional average. In 2015, World Energy Outlook submitted that access to energy also includes consuming a specific quantity of electricity, which varies depending on whether the household is in a rural or urban area. The baseline power usage for rural households is 250 kilowatt-hours (kWh) per year, while the threshold for urban families is 500 kWh per year (IEA 2015). The IEA (2014) opined that modern energy services could only be harnessed if the energy supply is available, affordable, adequate, located nearby, and safe to use at desired hours of the day.

The majority of Sub-Saharan African countries lack modern electricity facilities. As a result, a sizable fraction of the population cooks with traditional biomass (Abeeku 2010). For example, about 20% of Senegal's population in West Africa uses Liquified Petroleum Gas (LPG), compared to less than 10% in Ghana (Economic Community of West African States

(ECOWAS) 2006). Nigeria is a significant oil producer and boasts Africa's second-largest natural gas reserve (Sambo 2008). According to the World Bank (2017), Nigeria had about 60% access rate to electricity in 2015, with 86% of urban regions and 41% of rural areas having access, while access to non-solid fuels was only 4%. Gas accounts for 80% of power generation today, with oil accounting for the remainder.

Generally, the review confirms that access to energy sources varies across global regions and is higher in developed than developing economies. Energy access depends on the rate at which energy is available, accessed, and used for basic human needs. However, available reports confirmed that access to energy in developing economies is low. In sub-Saharan Africa and West Africa, energy access is low in Nigeria compared to countries like Senegal and Ghana, although the country is blessed with energy-generating resources.

## 2.2 Factors Inhibiting Energy Access

Certain factors inhibit access to energy as needed for primary and general purposes. According to Beck and Martinot (2004) and World Bank (2008), some factors include economic and financial barriers, market performance, and legal and regulatory barriers. In another vein, Lipu et al. (2013) identified energy policy, housing policy, illegal settlement, financial barriers, awareness level, and lack of infrastructure to deliver energy services as the factors inhibiting energy access. A further attempt by Kojima and Trimble (2016) established that electricity access in Africa is hindered by the financial capability of utilities to meet supply and the ability of the households to pay. Ahlborg and Hammar (2011) affirmed that institutional and stakeholder performance, economy and finance, social dimensions, technical system and local management, technology diffusion and usage, and rural infrastructure inhibit energy access in sub-Saharan Africa.

In a study, Valencia and Caspary (2008) worked on implementing renewables-based electrification projects in various developing countries. The study asserted that inadequate financing mechanisms, information, lack of relevant investments in energy policies, and institutional and decision-making barriers inhibit energy access. Other factors include technology choices, lack of follow-up, and project abandonment. Power Africa (2018) also identified the financial health of the energy sector, legacy debt, limited creditworthiness of utilities, short-term facilities' generation capacity, over-contracting of new plants, and a high cost of generation as factors inhibiting energy access in Ghana. Others include the lack of transparency in the procurement framework and the lack of solid and transparent regulatory precedents to drive competition.

Ashish (2015) argued that the barriers inhibiting energy access are the financial barrier, informal settlement, alternate supply mechanism, institutional barrier, awareness barrier, and settlement consumption and income. Dioha and Emodi (2019) posited that Nigeria's energy access barriers are low household income, inadequate financing, inadequate planning, poor governance, and weak institutional and human capabilities. In Kenya, Kioli and Ngare (2019) argued that energy access is inhibited by the high cost of installation and tariff price for consumers, expensive financing of energy infrastructure, slow adoption of clean and renewable energy compared to other energy sources, and shortage of facilities to handle cheaper energy resources. Others include inadequate fiscal and incentives for private sector investment, inadequate energy access data, lack of prioritisation of energy needs of poor communities, and inadequate participation by communities, civil society, and social enterprises in national and county energy planning and decision making.

The review revealed that global reports and some empirical works on access to energy sources affirmed that certain factors inhibit access to energy globally, including in developing countries and sub-Saharan Africa. However, none of the previous studies specifically considered the construction industry. Hence, there is insufficient knowledge of the factors inhibiting access to energy in the construction industry. Additionally, the studies showed no investigation into the Nigerian energy situation. Hence, adapting the results and findings from other countries could pose the danger of ecological fallacy. After a comprehensive literature review, 16 factors were identified from previous studies, as presented in Table 1.

### 2.3 Benefits of Energy Access in the Delivery of Construction Projects

An extant literature review revealed an increasing number of studies on the benefits of energy access. However, these studies focused on rural SMEs (Tarun et al. 2013), health (Porcaro 2017), education (Guyu 2017; Olanrele et al. 2020; Sovacool 2014; Wagner et al. 2017; World Bank 2008), and general development (Barnes et al. 2014; Muawya and Walter 2012; Trace 2016). Thus, this study will investigate the benefits of energy access in the delivery of construction projects. After a comprehensive literature review and desk review, 11 benefits were identified from previous research (see Table 2). The most frequently mentioned benefits are efficacy in project delivery and increased productivity.

### 2.4 Summary of Literature

An extensive literature review identified the factors inhibiting energy access and the benefits of energy access. Thus, the extensive literature review produced 16 factors inhibiting energy access (Table 1) and 11 benefits of energy access (Table 2).

**Table 1**: Identified factors inhibiting energy access

| Ref. code | Factors inhibiting energy access | Sources |
|---|---|---|
| F1 | Government regulation | Dioha and Emodi (2019) |
| F2 | Knowledge and information gap | Ashish (2015); Lipu et al. (2013); Valencia and Caspary (2008); World Bank (2017) |
| F3 | Low level of human capacity | Dioha and Emodi (2019); World Bank (2017) |
| F4 | Lack of prioritisation of energy needs | Kioli and Ngare (2019) |
| F5 | Inadequate energy access data | Kioli and Ngare (2019) |
| F6 | Lack of institutional framework | Ahlborg and Hammar, 2011; Ashish (2015); Dioha and Emodi (2019); World Bank (2017) |
| F7 | Efficient supply and distribution | World Bank (2017) |
| F8 | Inadequate infrastructure | Aliyu et al. (2013); World bank (2017); Ahlborg and Hammar, 2011; Kioli and Ngare (2019); Lipu et al. (2013) |
| F9 | Expensive funding of energy infrastructure | Kioli and Ngare (2019) |
| F10 | Corruption | Aliyu et al. (2013); Ashish (2015); Power Africa (2018) |
| F11 | Market performance | Pirlogea (2011); World Bank (2008) |
| F12 | Low level of policy and regulation | Aliyu et al. (2013); Lipu et al. (2013); World Bank (2017) |
| F13 | Financial barriers | Ahlborg and Hammar (2011); Ashish (2015); Dioha and Emodi (2019); Kioli and Ngare (2019); Kojima and Trimble (2016); Power Africa (2018); Lipu et al. (2013); Valencia and Caspary (2008); World Bank (2008); World Bank (2017) |
| F15 | Lack of economic incentives to invest in rural areas | Aliyu et al. (2013) |
| F16 | Slow adoption of clean and renewable energy technologies | Kioli and Ngare (2019); Power Africa (2018) |

**Table 2**: Identified benefits of energy access

| Ref. code | Benefits of energy access | Sources |
|---|---|---|
| B1 | Reduces the stress of manual labour | Tarun et al. (2013) |
| B2 | Increased employment | Muawya and Walter (2012) |
| B3 | Improved lighting conditions | Tarun et al. (2013); Porcaro (2017); Muawya and Walter (2012); Sovacool (2014) |
| B4 | Saves cost over time | Tarun et al. (2013) |
| B5 | Triggers efficacy in project delivery | Barnes et al. (2014); Muawya and Walter (2012); Tarun et al. (2013); Trace (2016); Sovacool (2014); Wagner et al. (2017); World Bank (2008) |
| B6 | Enterprise creation | Tarun et al. (2013); Muawya and Walter (2012) |
| B7 | Fast-tracked project delivery | Porcaro (2017) |
| B8 | Improved economy | Barnes et al. (2014); Muawya and Walter (2012); Trace (2016) |
| B9 | Increased productivity | Barnes et al. (2014); Muawya and Walter (2012); Trace (2016); Wagner et al. (2017) |
| B10 | Use of communication technologies | Porcaro (2017); Trace (2016) |
| B11 | Improved effectiveness of project delivery | Porcaro (2017) |

## 3.0 Research Methodology

This paper examined energy access in the execution of construction projects in the Lagos metropolis. Lagos metropolis is in the Southwestern part of Nigeria; it is the centre of economic activities in the nation, making it the most populated city. In addition, the rapid population growth in Lagos due to immigration from other parts of the country necessitated the development of more buildings and infrastructures. Thus, Lagos is the hub of construction activities in Nigeria. The research employed quantitative analysis through a questionnaire survey. According to the Lagos State Ministry of Work (LSMW) (2015), there are 345, 350 and 200 small, medium, and large-sized construction companies in Lagos Metropolis. This gives a total of 895 construction firms. A purposive sampling technique was employed to select 35, 56 and 88 small, medium, and large-sized construction companies, respectively, giving 179 (20% of all) construction companies. The researcher visited 179 construction companies and dropped one copy of the questionnaire in each company. However, 89 construction companies, including 15 small, 32 medium and 42 large-sized, responded to the questionnaire survey. This gives a response rate of 49.7 per cent of the sample size.

The questionnaire contained four sections, Sections A to D. The background information of each company and its responding officer were solicited in Section A. Information collected in this section includes the size of the firm, its revenues, the designation of the responding officers, their highest academic qualifications, and years of work experience. On the other hand, Section B examined the level of access to these energy sources in the delivery of construction activities in the Lagos metropolis. At the same time, Section C assessed factors inhibiting energy access for construction activities. Moreover, Section D examined the benefits of energy access for construction activities in the Lagos metropolis. Responses to the questions in Section A were obtained on a descriptive scale using percentages, while in Sections B, C, and D, responses from the respondents were obtained on a five-point Likert scale.

After the questionnaire had been prepared, it went through a series of reviews and assessment processes by the research supervisor. This is to check for the internal validity and consistency of the research instrument by leveraging the experiences of the research supervisor. This is very important to ensure that the respondents fully understand the purpose that each research question asked in the questionnaire aims to achieve. Once the final approval was received, copies of the questionnaire were administered physically in face-to-face contact with the respondents by the principal researcher. A physical approach was employed to administer copies of the questionnaire because of the lack of a database of construction companies through which their emails could be obtained for the online survey. The principal researcher, the lead author of this paper, physically administered copies of the questionnaire to the respondents. The study was conducted during the 2018/2019 academic session, and copies of the questionnaire survey were administered to the respondents between November 2019 and January 2020.

A total of 179 copies of questionnaires were distributed. However, only 89 retrieved questionnaires were adequate for analysis —a response rate of 49.7%. Data obtained through questionnaire surveys administered to the respondents were analysed using IBM SPSS Version 23. Descriptive and inferential statistical techniques were employed to analyse the survey data collected. The descriptive statistics used were frequency, percentages, and mean score ranking, while the inferential statistics used were the Kruskal-Wallis test and factor analysis. Frequency distribution in percentage was used to measure and present the profile of the construction companies and the corresponding officers that responded to the survey. In contrast, the mean score measured the rate at which the respondents responded to the variables in answering each of the questions asked in Sections B, C, and D. Shapiro-Wilk test was conducted to test the normality of the data. The result revealed that the data collected did not meet the assumption of a normal distribution. Hence, the Kruskal-Wallis test was employed to determine whether there is an agreement on how each class of respondents perceived the variables measured under each of the questions raised in various sections.

**Table 3: KMO and Bartlett's Test for Factors Inhibiting Energy Access**

| | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | .791 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 686.490 |
| | Df | 153 |
| | Sig. | .000 |

The relationship among the identified factors inhibiting energy access was determined using factor analysis. Furthermore, Kaiser-Meyer Olkin (KMO) and Bartlett's test of sphericity were used to ascertain the validity of the retrieved data for factor analysis. A KMO value above 0.5 and a significance level below 0.05 indicates a substantial correlation in the data, which makes it adequate for factor analysis (See Table 3).

## 4.0 Results and Discussion

This section presents the results of the data analysis collected from the respondents to this study. The data collected and analysed include the background profile of the construction companies and their corresponding officers, level of access to energy sources, factors inhibiting energy access, and benefits of energy access in the delivery of construction projects in Lagos Metropolis.

**Table 4: Background Information on Firms and Responding Officers**

| Profile | Frequency | Percent |
|---|---|---|
| **Size of the Construction Companies** | | |
| Small | 15 | 16.8 |
| Medium | 32 | 36.0 |
| Large | 42 | 47.2 |
| **Annual Revenues/Turnovers of the Firms (Naira)** | | |
| ₦(0–20)million | 22 | 24.7 |
| ₦(21–40)million | 10 | 11.2 |
| ₦(41–60)million | 8 | 9.0 |
| ₦(61–80) million | 6 | 6.7 |
| ₦(above 80)million | 43 | 48.4 |
| **Mean = ₦41.5million** | | |
| **Highest Academic Qualifications of the Respondents** | | |
| Ordinary National Diploma (OND) | 13 | 14.6 |
| Ordinary National Diploma/Postgraduate Diploma (HND/PGD) | 34 | 38.2 |
| Bachelor of Science (BSc) | 35 | 39.3 |
| Master of Science (MSc) | 7 | 7.9 |
| **Professional Designations of the Respondents** | | |
| Architects | 6 | 6.7 |
| Quantity Surveyors | 25 | 28.1 |
| Builders | 20 | 22.5 |
| Engineers | 38 | 42.7 |
| **Years of Work Experiences of the Respondents** | | |
| 0 – 5years | 31 | 34.8 |
| 6 – 10years | 35 | 39.3 |
| 11 – 15years | 15 | 16.9 |
| 16 – 20years | 3 | 3.4 |
| Above 20years | 5 | 5.6 |
| **Mean = 7.88years** | | |

1USD = 700Naira (₦)

## 4.1 Background Information on Firms and Responding Officers

This section presents information on the background profiles of the responding officers who provided answers to the questions raised in this research. The result is presented in Table 4. It emerged that 15 (16.8%) are small companies, 32 (36.0%) are medium companies, and 42 (47.2%) are large companies. The results show that most of the respondents that responded to the questionnaire survey are medium to large size companies whose information about annual revenues shows that approximately 20% have annual revenues above 20 million naira. In contrast, more than 48% are above 80 million naira. An evaluation of the academic qualification of the responding officers showed that about 39.3% have B. Sc. while only 7.9% have M.Sc. However, the highest proportion of the responding officers are engaged as engineers, 38 (42.7%). This is because engineers are more predominant on site. The least represented professionals, 6 (6.7%), are architects. This is because most architects are not residents on site. Instead, a clerk of work represents them. Sixty-six responding officers (65.2%) have been in the construction business for fewer than ten years, whereas only 23 (25.9%) have been there for longer than ten years.

## 4.2 Level of Access to Energy

In this section, the assessment of the level at which construction companies access available energy sources for project delivery was conducted by independently and jointly evaluating the opinions of three classes of construction firms in the study area, as shown in Table 5. The evaluation was conducted using a 5-point Likert scale, ranging from 0 to 5. The small-sized construction companies surveyed rated automotive gas oil (diesel) (M=4.57), premium motor spirit (petrol) (M=4.29), and liquefied petroleum gas (M=4.29) as the top-ranked sources of energy with a very high level of access for the delivery of construction projects, whereas electricity (power grid) (M=4.00) was considered to be the energy source with the least level of access.

**Table 5: Level of Access to Energy based on Size of Firm**

| S/N | | Overall | | Size of firm | | | | | | Kruskal Wallis |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Small | | Medium | | Large | | |
| | | Mean | Rk | Mean | Rk | Mean | Rk | Mean | Rk | Sig. |
| 1 | Automotive gas oil (diesel) | 4.24 | 1 | 4.57 | 1 | 4.22 | 2 | 4.19 | 1 | .295 |
| 2 | Premium Motor Spirit (petrol) | 4.13 | 2 | 4.29 | 2 | 4.34 | 1 | 3.93 | 2 | .560 |
| 3 | Liquified petroleum gas | 3.93 | 3 | 4.29 | 2 | 3.88 | 3 | 3.90 | 3 | .814 |
| 4 | Electricity (power grid) | 3.60 | 4 | 4.00 | 4 | 3.59 | 4 | 3.57 | 4 | .784 |

S/N- serial number; RK- rank; Sig.- siginificance level

From the perspective of medium-sized construction companies, the top-ranked sources of energy with a high level of access for construction project delivery were premium motor spirit (petrol) (M=4.34) and automotive gas oil (diesel) (M=4.22). In contrast, electricity (power grid) was identified as the least-ranked source of energy with a moderate level of access. Large-sized construction companies shared similar views, with automotive gas oil (diesel) (M=4.19) and premium motor spirit (petrol) (M=3.93) being the top-ranked sources of energy with very high access for construction project delivery, while electricity (power grid) (M=3.57) was considered the least ranked source of energy with a moderate level of access.

Overall, the construction companies' opinions indicated that automotive gas oil (diesel) (M=4.20), premium motor spirit (petrol) (M=4.13), and liquefied petroleum gas (M=3.93) were the sources of energy with high access for project delivery across all company sizes. In contrast, all construction companies agreed that electricity (power grid) (M=3.60) was the least available energy type for the delivery of construction projects.

A Kruskal Wallis test was conducted to determine whether the opinions of all classes of construction companies on their level of access to the available sources of energy agree or disagree. The test reveals that all classes share similar views on the level of access to available energy sources.

### 4.3 Factors Inhibiting Energy Access

This section examines the extent to which certain factors identified in the literature inhibit access to energy sources by the construction companies surveyed to deliver construction projects. The examination of these inhibiting factors was done in a cross-sectional approach across the three classes of construction companies surveyed and from the opinions of the small-sized construction companies (See Table 6), the top and a very high-ranking factor that inhibits access to sources of energy is government regulation (M=4.57). Other factors that strongly inhibit access to energy sources are financial barriers, financial speculations, and a low level of policy attention, each with a mean score of 4.29. Similar factors with strong inhibiting influence are the funding gap (MS=4.14), level of supply (M=4.00), and level of demand (M=4.00), including global influence, low level of human capital, gas storage, and generation changes, with each having mean score of 3.71.

**Table 6: Factors Inhibiting Energy Access Based on Size of Firm**

| S/N | | Size of firm | | | | | | | | Kruskal Wallis Sig. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Overall | | Small | | Medium | | Large | | |
| | | Mean | Rk | Mean | Rk | Mean | Rk | Mean | Rk | |
| 1 | Efficient supply and distribution | 4.06 | 1 | 3.57 | 13 | 4.53 | 1 | 3.78 | 10 | .656 |
| 2 | Government regulation | 4.01 | 2 | 4.57 | 1 | 4.19 | 2 | 3.79 | 9 | .092 |
| 3 | Inadequate Infrastructure | 3.96 | 3 | 4.00 | 6 | 4.03 | 3 | 3.90 | 2 | .893 |
| 4 | Knowledge and information gap | 3.91 | 4 | 3.86 | 7 | 3.69 | 10 | 4.10 | 1 | .481 |
| 5 | Financial barriers | 3.90 | 5 | 4.29 | 2 | 3.94 | 4 | 3.79 | 8 | .386 |
| 6 | Low level of human capacity | 3.90 | 5 | 4.29 | 2 | 3.91 | 7 | 3.83 | 5 | .448 |
| 7 | Expensive funding of energy infrastructure | 3.86 | 7 | 4.14 | 5 | 3.77 | 9 | 3.88 | 3 | .544 |
| 8 | Corruption | 3.86 | 7 | 3.71 | 9 | 3.94 | 4 | 3.83 | 5 | .798 |
| 9 | Lack of economic incentives to invest in rural areas | 3.83 | 9 | 3.86 | 7 | 3.84 | 8 | 3.80 | 7 | .969 |
| 10 | Low level of policy and regulation | 3.80 | 10 | 4.29 | 2 | 3.59 | 12 | 3.88 | 3 | .207 |
| 11 | Lack of institutional framework | 3.80 | 10 | 3.43 | 14 | 3.94 | 4 | 3.76 | 11 | .419 |
| 12 | Slow adoption of clean and renewable energy technologies | 3.70 | 12 | 3.71 | 9 | 3.62 | 11 | 3.76 | 11 | .980 |
| 13 | Inadequate energy access data | 3.62 | 13 | 3.71 | 9 | 3.56 | 14 | 3.66 | 13 | .936 |
| 14 | Lack of prioritisation of energy needs | 3.56 | 14 | 3.71 | 9 | 3.59 | 12 | 3.51 | 14 | .928 |
| 15 | Market performance | 3.35 | 15 | 3.00 | 16 | 3.38 | 15 | 3.39 | 16 | .550 |
| 16 | Climate change agenda | 3.34 | 16 | 3.43 | 14 | 3.19 | 16 | 3.44 | 15 | .587 |

S/N- serial number; RK- ranking; Sig.- siginificance level

The least ranked factors from the perspectives of small-sized construction companies with moderate inhibiting influence on access to energy sources are weather forecast (M=3.00), including import and export, lack of institutional framework, and climate change agenda, with each having a mean score of 3.43. From the views of medium-sized construction companies, the top-ranking factor with a strong inhibiting influence in accessing energy sources for the delivery of construction projects is the export of energy to neighbouring countries (M=4.53). Other factors with a high inhibiting influence in accessing energy sources are government regulation (M=4.19), level of supply (M=4.03), import and export (M=3.97), including financial barriers, global influence, and lack of institutional framework, each having a mean score of 3.94.

However, climate change (M=3.19), weather forecast (M=3.38), gas storage (M=3.56), low level of policy attention (M=3.59), and generation changes (M=3.59) are the least ranked factors. However, they also have high inhibiting influence on accessing energy for construction project delivery in the study area. In large-sized construction companies, the top-ranked factors that have a high inhibiting influence on access to sources of energy in the delivery of construction projects include knowledge gap (M=4.10), level of supply (M=3.90), import and export, funding gap, and low level of policy attention each having mean score of 3.88. On the other hand, factors with the least inhibiting influence on accessing sources of energy for the delivery of construction projects are weather forecast (M=3.39), climate change agenda (M=3.44), generation changes (M=3.51), gas storage (M=3.66) including lack of institutional framework and low level of human capacity with each having a mean score of 3.76.

Having examined the individuals' views of all classes of construction companies surveyed, their overall views were examined, and the results show that the top-ranked factor with high inhibiting influence in accessing sources of energy for the delivery of construction projects is the export of energy to neighbouring countries (M=4.06). Other factors with a high inhibiting influence on accessing energy are government regulation (M=4.01), level of supply (M=3.96), and knowledge gap (M=3.91), including financial barriers and financial speculations, each having a mean score of M=3.90. On the other hand, the least ranked factors with moderate inhibiting influence on accessing energy sources for construction project delivery are climate change agenda (M=3.34) and weather forecast (M=3.35).

To test whether the opinions of all classes of construction companies agree or disagree on how the identified factors inhibit the rate at which small, medium, and large-sized construction companies access sources of energy for the delivery of construction projects, a Kruskal Wallis test was carried out. The test results reveal a significant difference in how all construction companies perceived government regulation (Sig=0.092, $P \leq 0.05$) as a factor inhibiting access to energy sources for the delivery of construction projects. This shows that their opinions differ on how government regulation influences access to energy for the delivery of construction projects. The result also reveals that their opinions agree on other factors inhibiting their level of access to energy sources in the delivery of construction projects in the study area.

### 4.3.1 Factor Analysis of the Factors Inhibiting Energy Access

The result in Table 7 shows the principal factor extraction and varimax rotation of the 16 identified factors inhibiting energy access in the delivery of construction projects. The eigenvalues for the four factors ranged from 1.051 to 6.955, and the percentage of variance explained by the 1st factor is 38.638%, the 2nd factor is 9.410%, and the 3rd factor is 8.176%, the 4th factor is 5.837%. The cumulative percentage of variance, explained by the extracted four factors, accounted for 62.061%.

**Table 7: Principal Factor Extraction and Varimax Rotation of the Factors Inhibiting Energy Access**

| Factors | Factors loading | Total | % of variance | Cumulative % |
|---|---|---|---|---|
| **Factor 1: Economic related Barrier** | | **6.955** | **38.638** | **38.638** |
| Expensive funding of energy infrastructure | .832 | | | |
| Government regulation | .798 | | | |
| Efficient supply and distribution | .652 | | | |
| Corruption | .578 | | | |
| Financial barrier | .577 | | | |
| Lack of economic incentives to invest in rural areas | .451 | | | |
| **Factor 2: Infrastructure and Knowledge Barrier** | | **1.694** | **9.410** | **48.048** |
| Low level of human capacity | .747 | | | |
| Inadequate Infrastructure | .724 | | | |
| Knowledge and information gap | .714 | | | |
| Market performance | .634 | | | |
| Inadequate energy access data | .600 | | | |
| **Factor 3: Institutional Barrier** | | **1.472** | **8.176** | **56.224** |
| Lack of prioritisation of energy needs | .773 | | | |
| Slow adoption of clean and renewable technologies | .674 | | | |
| Lack of institutional framework | .627 | | | |
| Low level of policy and regulation | .617 | | | |
| **Factor 4: Environmental Related Barrier** | | **1.051** | **5.837** | **62.061** |
| Climate change agenda | .820 | | | |

Extraction method: Principal Component Analysis

The 16 identified factors are grouped into four principal factors as follows:

- Factor 1: Economic-related barriers
- Factor 2: Infrastructure and knowledge barrier
- Factor 3: Environmental-related barrier
- Factor 4: Institutional factor

**i. Factor 1: Economic-related factors**

This factor accounts for 38.638% of the total variance of the factors inhibiting energy access, with loading variables having a score that ranged from 0.451 to 0.832. The six components include expensive energy infrastructure funding, government regulation, efficient supply and distribution, corruption, financial barrier, and lack of economic incentives to invest in rural areas. The six components have a factor loading of 0.832, 0.798, 0.652, 0.578, 0.577, and 0.451, respectively. Finance is a significant factor that influences energy access. Thus, the government must be willing to make an adequate financial commitment to facilitate energy access in Nigeria.

**ii. Factor 2: Infrastructure and knowledge-related barrier**

This factor accounts for 9.410% of the total variance of the factors inhibiting energy access, with loading variables having a score that ranged from 0.600 to 0.747. The five components include a low level of human capacity, inadequate infrastructure, knowledge and information gap, market performance, and inadequate energy access data. The five components have a factor loading of 0.747, 0.724, 0.714, 0.634, and 0.600, respectively. Thus, adequate energy infrastructure and technical knowledge are critical to combat energy access in Nigeria.

**iii. Factor 3: Institutional Barrier**

This factor accounts for 8.176% of the total variance of the factors inhibiting energy access, with loading variables having a score that ranged from 0.617 to 0.773. The four components include lack of prioritisation of energy needs, slow adoption of clean and renewable technologies, lack of institutional framework, and low level of policy and regulation. The five components have a factor loading of 0.773, 0.674, 0.627, and 0.617, respectively. Therefore, the government must prioritise the need for adequate access to energy in the nation and make policies promoting energy access.

**iv. Factor 4: Environmental Related Factor**

This factor accounts for 5.837% of the total variance of the factors inhibiting energy access, with loading variables having a score of 0.820. The factor is made up of only one component: the climate change agenda.

## 4.4 Benefits of Energy Access in the Delivery of Construction Projects

The previous section examined the factors inhibiting access to energy for the delivery of construction projects in Lagos Metropolis. However, this section investigates the benefits of access to energy in the delivery of construction projects. The result is presented in Table 8. For small firms, the top-ranked benefits of access to energy are improved economy, efficacy in project delivery, and increased employment (MS= 4.50, 4.43, and 4.33, respectively). Enterprise creation was the least significant benefit of energy access (MS= 3.50). The top-ranked benefits of energy access by medium firms are fast-tracked delivery of construction projects, increased productivity, and improved effectiveness of project delivery (MS= 4.78, 4.72, 4.48, respectively). The least significant benefit of energy access was increased employment (MS= 4.09).

From the perspectives of medium-sized construction companies, the top-ranked benefits of energy access are improved economy, increased productivity, and fast-tracked construction project delivery (MS= 4.50, 4.41, and 4.32, respectively). The least significant benefit of energy access was saved cost over time (MS= 3.85). The overall evaluation of the general view of the respondents on the benefits of energy access in construction project delivery revealed that the top-ranked benefits are increased productivity, fast-tracked construction project delivery, and improved economy (MS= 4.53, 4.50, and 4.46, respectively). The least ranked benefit of energy access in construction project delivery was improved lighting conditions (MS= 4.05). These results conform with the previous research findings that identified the highlighted benefits as significant benefits of energy access (ACP-EU Energy Facility, 2010; Barnes, 2014; Muawya & Walter, 2012; Tarun et al., 2013; Trace, 2016; Wagner et al., 2017).

**Table 8:** Benefits of Energy Access on Construction Project Delivery Based on Size of Firm

| S/N | | Size of firm | | | | | | | | Kruskal Wallis |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Overall | | Small | | Medium | | Large | | |
| | | Mean | Rk | Mean | Rk | Mean | Rk | Mean | Rk | Sig. |
| 1 | Increased productivity | 4.53 | 1 | 4.29 | 4 | 4.72 | 2 | 4.41 | 2 | .209 |
| 2 | Fast-tracked construction project delivery | 4.50 | 2 | 4.29 | 4 | 4.78 | 1 | 4.32 | 3 | .028 |
| 3 | Improved economy | 4.46 | 3 | 4.50 | 1 | 4.41 | 5 | 4.50 | 1 | .869 |
| 4 | Improved effectiveness of project delivery | 4.36 | 4 | 4.29 | 4 | 4.48 | 3 | 4.28 | 4 | .773 |
| 5 | Reduced stress of manual labour | 4.30 | 5 | 4.14 | 7 | 4.44 | 4 | 4.22 | 5 | .545 |
| 6 | Use of communication technologies | 4.24 | 6 | 4.00 | 9 | 4.38 | 6 | 4.18 | 7 | .909 |
| 7 | Triggers efficacy in project delivery | 4.20 | 7 | 4.43 | 2 | 4.38 | 6 | 4.02 | 9 | .514 |
| 8 | Increased employment | 4.18 | 8 | 4.33 | 3 | 4.09 | 11 | 4.22 | 5 | .859 |
| 9 | Enterprise creation | 4.08 | 9 | 3.50 | 11 | 4.13 | 10 | 4.13 | 8 | .372 |
| 10 | Saves cost overtime | 4.07 | 10 | 4.14 | 7 | 4.34 | 8 | 3.85 | 11 | .200 |
| 11 | Improved lighting conditions | 4.05 | 11 | 3.71 | 10 | 4.19 | 9 | 4.00 | 10 | .694 |

The Kruskal Wallis test was employed to test respondents' level of agreement on the impacts of energy access on construction projects. The result in Table 8 indicated that eleven of the twelve identified benefits had a significance value greater than 0.05. This implies that the respondents across the firm's size do not differ in their rankings of these benefits. However, one of the benefits had a Kruskal Wallis significance value of less than 0.05: it makes construction project delivery faster (sig= 0.028). Again, this implies a difference in the perception of respondents on this benefit based on the firm's size.

## 4.5 Discussion of Findings

The study identified diesel, petrol, and gas as the primary sources of energy for the delivery of construction projects in Lagos Metropolis. This finding aligns with a previous study conducted by Talukhaba et al. (2013), which reported that diesel, petrol, and gas are commonly used energy sources in construction activities. These findings are consistent with Nigeria's broader energy access situation, as highlighted by Oyedepo (2012). Oyedepo argued that a significant proportion of the Nigerian population lacks access to electricity, with estimates ranging from 60% to 70%. Abeeku (2010) states that most sub-Saharan countries have low access to the modern energy system and that the region's energy level is poor compared to other nations in the developing world, especially for housing needs like cooking. Among the top in West Africa, where Nigeria is the acclaimed giant, Senegal has more than 20% of its population using LPG, while Ghana has less than 10% (ECOWAS, 2006). World Bank (2015) also confirmed that the electricity access rate in Nigeria was nearly 60% in 2015, with 86% of urban areas and 41% of rural areas with access. Most or nearly 80% of power generation comes from gas, while most of the remainder comes from oil, with Nigeria being the continent's largest user of oil-fired backup generators. In the country's commitment to implementing the vision of SEforALL, the country set some targets, which include increasing electricity access to 75% (urban = 90%) and rural= 60%) by 2020 and to 90% by 2030.

The delivery of construction projects in the Lagos Metropolis is hindered by several factors that limit access to energy sources. The primary challenges identified in this study include regional and national policies on energy, supply chain systems, and economic issues. These findings are consistent with the research conducted by Beck and Martinot (2004) and the World Bank (2008), which found that economic and financial barriers, market performance, and legal and regulatory barriers limit construction companies' access to energy sources. Similarly, Lipu et al. (2013) identified energy policy, illegal settlements, financial barriers, low awareness levels, and lack of infrastructure for energy service delivery as key barriers to energy access. Additionally, Kojima and Trimble (2016) established that electricity access in Africa is impeded by the financial capability of utilities to meet demand and the ability of households to pay for energy services. Another view, presented by Ahlborg and Hammar (2011), highlights the significant impact of institutional performance, economy and finance, social dimensions, technical system, technology diffusion, adaptation, and rural infrastructure on energy access in sub-Saharan Africa. These findings suggest that improving the institutional framework, enhancing financing options, increasing awareness of available energy sources, and developing infrastructure for energy service delivery could help overcome the barriers to accessing energy sources for construction projects in Lagos Metropolis and other regions in sub-Saharan Africa.

## 5.0 Conclusion and Future Research

This paper examines factors inhibiting energy access in the delivery of construction projects in Lagos Metropolis. The specific objectives examined the level of access to energy sources and evaluated factors inhibiting access to the sources of energy in the delivery of construction projects in the study area. A quantitative research approach was employed in collecting and analysing the data reported in the paper. First, a literature review was carried out to identify the relevant variables of research constructs, including energy sources, level of access to energy sources, and factors inhibiting the level of access to energy sources. The variables identified in the literature were used to design the research instrument for the study. Data were collected from construction companies in the study area through a questionnaire survey and analysed using descriptive and inferential statistics.

Based on the specific objectives of the paper, the paper concludes that the energy sources available for the delivery of construction projects in the study area are non-renewable sources such as diesel, petrol, and gas. This implies heavy reliance on non-renewable energy sources in the delivery of construction projects. This high reliance on non-renewable energy sources has adverse implications for the construction industry's environment, energy security, and cost-effectiveness. Thus, one of the implications of this study is the need to move towards massive adoption of renewable energy sources in the construction industry. The onus is, therefore, on the Nigerian government to prioritise the development of renewable energy potentials in the construction industry and the country. The government should provide incentives and subsidies to energy users.

Similarly, policymakers, energy planners, and industry stakeholders must develop strategies for promoting and adopting sustainable energy use in the construction sector. In this regard, future research should be conducted to identify strategies for promoting the uptake and adoption of renewable energy sources by companies of different types and sizes in the delivery of construction projects. The policies and regulatory frameworks needed for adopting renewable energy in the construction industry should be investigated.

The study identified sixteen factors inhibiting energy access, grouped into four principal factors by factor analysis. They are economic, infrastructure and knowledge, environmental, and institutional barriers. These four principal factors provide a framework for further exploration and identification of specific interventions that can effectively address each of these barriers. Hence, it is recommended that future research should be carried out to identify and develop effective interventions to address each identified category of barriers.

## References


Abeeku, B. 2010. Energy access in Africa: Challenges ahead. *Energy Policy*, 38 (5), 2291-2301. https://doi.org/10.1016/j.enpol.2009.12.016

Ajayi, O, Ajanaku K. 2009. Nigeria's Energy Challenge and Power Development: The Way Forward**.** *Energy and Environment*, 20(3), 411 - 413. https://core.ac.uk/download/pdf/12356025.pdf

Ahlborg, H, Hammar, L. 2011. Drivers and Barriers to Rural Electrification in Tanzania and Mozambique - Grid Extension; Off-Grid and Renewable Energy Sources., *World Renewable Energy Congress, Linköping, Sweden. 2493–2500. https://ep.liu.se/ecp/057/vol10/028/ecp57vol10_028.pdf*

Aliyu, A, Ramli, A, Saleh, M. (2013). Nigeria electricity crisis: power generation capacity expansion and environmental ramifications. *Energy*, 61, 354–367. https:// doi.org/10.1016/j.energy.2013.09.011

Ashish, M. 2015. Interlinking Energy Access Consumption and Energy Carriers- Case Study of Formal and Informal Settlements, Darbhanga, India. [Master Thesis. Norwegian University of Science and Technology]. Retrieved from https://www.academia.edu/14523879/Interlinking_Energy_Access_Consumption_and_Energy_Carriers

Aydın, F. 2010. Energy consumption and economic growth. *Journal of Erciyes University, Faculty of Economics and Administrative Science*, (35), 317-340. Retrieved from https://dergipark.org.tr/en/download/article-file/66570

Barnes, D, Samad, H, Banerjee, S. 2014. The Development Impact of Energy Access. *Energy poverty: global challenges and local solutions. U.K.: Oxford Scholarship.* DOI:10.1093/acprof:oso/9780199682362.003.0004

Beck, F, Martinot, E. 2004. Renewable Energy Policies and Barriers, Editor(s): Cutler J. Cleveland, Encyclopedia of Energy, 365-383. https://doi.org/10.1016/B0-12-176480-X/00488-5.

Canadian Architect. 2010. Measures of sustainability. Retrieved from http://www.canadianarchitect.com/asf/perspectives_sustainibility/measures_of_sustaina blity/measures_of_sustainablity_embodied.htm.

Crowther, P. 1999. Design for Disassembly to Recover Embodied Energy, Proceedings of 16th International Conference on Passive and Low Energy Architecture, Melbourne. Retrieved from https://eprints.qut.edu.au/2846/1/Crowther-PLEA1999.PDF

Chaurey, A, Kandpal, T. 2010. Assessment and evaluation of P.V. based decentralised rural electrification: An overview. *Renewable and Sustainable Energy Reviews*, 14(8), 2266 - 2278. https://doi.org/10.1016/j.rser.2010.04.005

Dioha, M, Emodi, N. 2019. Investigating the Impacts of Energy Access Scenarios in the Nigerian Household Sector by 2030. *Resources*, 8(3). https://doi:10.3390/resources8030127

Ding, G. 2004. The Development of a Multi-Criteria Approach for the Measurement of Sustainable Performance for Built Projects and Facilities [Doctoral thesis, University of Technology, Sydney]. Retrieved from https://opus.lib.uts.edu.au/handle/10453/20191

Dixit, M, Fernández-Solís, J, Lavy, S, Culp, C. 2010a. Identification of Parameters for Embodied Energy Measurement: A Literature Review. *Energy and Buildings*, 42(8), 1238–1247. https://doi.org/10.1016/j.enbuild.2010.02.016

Dixit, M, Fernández-Solís, J, Lavy, S, Culp, C. 2010b. Protocol for Embodied Energy Measurement Parameters, TG66-Special Track 18th CIB World Building Congress, Salford, United Kingdom, 188. Retrieved from https://immobilierdurable.eu/images/2128_uploads/___Dixit.pdf

Dixit, M, Culp, C,  Fernández-Solís, J. 2013. System boundary for embodied energy in buildings: A conceptual model for definition. *Renewable and Sustainable Energy Reviews*, 21, 153-164. https://doi.org/10.1016/j.rser.2012.12.037.

Ecowas. 2006. White paper for a regional policy: Geared towards increasing access to energy services for rural and periurban populations in order to achieve the Millennium Development Goals. Economic Community of West African States, Abuja, Nigeria. Retrieved from https://digitallibrary.un.org/record/602225

Effiness C, Andrew, B, Brian, S. 2016. Embodied energy and carbon analysis of urban residential buildings in Malawi. *International Journal of Construction Management*, 16, 1, 1-12, http://dx.doi.org/10.1080/15623599.2015.1110274

Eleri, E, Ugwu, O, Onuvae, P. 2012. Expanding access to pro-poor energy services in Nigeria. Abuja, Nigeria: International Centre for Energy, Environment & Development

Energy sage. 2019. Solar energy: what you need to know.

Energy Sector Management Assistance Program (ESMAP). 2015. Energy Sector Management Assistance Program (ESMAP) Washington, D.C.: World Bank Group. http://documents.worldbank.org/curated/en/531971467987839055/Energy-Sector-Management-Assistance-Program-ESMAP-annual-report-2015

Guyu, Y. 2017. The impact of electricity access on education in Kenya [Unpublished Master's Thesis]. University of Illinois, Urbana-Champaign. Retrieved from https://www.ideals.illinois.edu/bitstream/handle/2142/97457/YE-THESIS-2017.pdf?isAllowed=y&sequence=1

Hendrickson, C, Horvath, A. 2000. Resource Use and Environmental Emissions of U.S. Construction Sectors. *Journal of Construction Engineering and Management*, 126(1), 38-44. https://doi.org/10.1061/(ASCE)0733-9364(2000)126:1(38)

Hegner, S. 2007. Embodied energy for energy efficiency measures, an assessment of embodied energy's relevance for energy saving in the Swiss residential building sector, Diploma Thesis, Department of Environment Science, ETH, Zurich, Switzerland.

Holtzhausen, H. 2007. Embodied energy and its impact on architectural decisions. WIT Transactions on Ecology and the Environment, 102, 377-385. https://doi.org/10.2495/SDP070361

Horvath, A. 2004. Construction materials and the environment. *Annual Review of Energy and The Environment*, 29, 181-204. https://doi.org/10.1146/annurev.energy.29.062403.102215

IEA. 2011. World Energy Outlook 2011, IEA, Paris https://www.iea.org/reports/worldenergy-outlook-2011

IEA. 2014. World Energy Outlook 2014, IEA, Paris https://www.iea.org/reports/worldenergy-outlook-2014

IEA. 2015. World Energy Outlook 2015, IEA, Paris https://www.iea.org/reports/worldenergy-outlook-2015

*IEA. 2017. Energy Access Outlook 2017, IEA, Paris https://www.iea.org/reports/energyaccess-outlook-2017*

IEA. 2019a. World Energy Outlook 2019, IEA, Paris https://www.iea.org/reports/worldenergy-outlook-2019

IEA. 2019b. Africa Energy Outlook 2019, IEA, Paris https://www.iea.org/reports/africa-energy-outlook-2019

Karanja, J, Ndunda, E, Mang'uriu, D, Ngare, I. 2017. Geothermal well Site Characteristics from Climate Resilient Technologies in Nakuru County, Kenya. *Journal of Research in Environmental and Earth Science*, 3(4), 01-05. Retrieved from https://irlibrary.ku.ac.ke/handle/123456789/17687

Kedar, U, Berit, B, Ulla, M, 2011. Promoting renewable energy in the construction sector using environmental impact assessment as a tool. *World Renewable Energy Congress 2011, Sweden,* http://dx.doi.org/10.3384/ecp110573002

Ki-moon, B. 2011. Sustainable energy for all: A vision statement. www.sustainableenergyforall.org

Kioli, J, Ngare, I. 2019. A Review of Energy Access in Kenya. *Journal of Electrical Engineering. 3(1).* Retrieved from https://researchjournali.com/pdf/5085.pdf

Kojima, M, Trimble, C. 2016. Making Power Affordable for Africa and Viable for its Utilities. World Bank, Washington, DC. Retrieved from http://hdl.handle.net/10986/25091

Langston, Y, Langston, C. 2008a. Reliability of building embodied energy modelling: an analysis of 30 Melbourne case studies. *Construction Management and Economics*, 26(2), 147-160. https://doi.org/10.1080/01446190701716564

Langston, Y, Langston, C. 2008b. Comparisons of Building Energy and Cost Equivalence: An Analysis of Thirty Melbourne Case Studies. *International Journal of Construction Management,* 8:2, 33-52, http://dx.doi.org/10.1080/15623599.2008.10773114

Lipu, M, Jamal, T, Miah, M. 2013. Barriers to Energy Access in the Urban Poor Areas of Dhaka, Bangladesh: Analysis of Present Situation and Recommendations.

*International Journal of Energy Economics and Policy*, 3(4), 395-411. Retrieved from https://dergipark.org.tr/en/pub/ijeeep/issue/31906/350748

Marszal, A. J, Bourrelle, J, Musall, E, Heiselberg, P, Gustavsen, A, Voss, K. 2010. Net zero energy buildings: calculation methodologies versus national building codes. Proceeding of International Conference on Solar Heating, Cooling and Buildings (EuroSun 2010), Graz, Austria. https://vbn.aau.dk/ws/portalfiles/portal/43739308/Net_Zero_Energy_Buildings.pdf

Muawya A, Walter L. 2012. Analysis of energy as a precondition for improvement of living conditions and poverty reduction in sub-Saharan Africa. *Scientific Research and Essays*, 7(30), 2656-2666. https://doi.org/10.5897/SRE11.929

Olanrele, I, Lawal, A, Dahunsi, S, Babajide, A, Olorunkanmi, J. 2020. The impact of access to electricity on education and health sectors in Nigeria's rural communities. *Entrepreneurship and Sustainability Issues*, 7(4), 3016-3035. https://doi.org/10.9770/jesi.2020.7.4(30)

Osueke, C, Ezugwu, C. 2011. Study of Nigeria Energy Resources and Its Consumption. *International Journal of Scientific & Engineering Research*, 2, (12), 1-8. Retrieved from https://www.ijser.org/viewPaperDetail.aspx?DEC1124

Oyedepo, S. 2012. Energy and sustainable development in Nigeria: the way forward. *Energy, Sustainability and Society*, 2, 15. https://doi.org/10.1186/2192-0567-2-15

Pirlogea, C. 2011. Barriers to Investment in Energy from Renewable Sources. *Economia Seria Management*, Faculty of Management, Academy of Economic Studies, Bucharest, Romania, 14(1), 132 – 140. Retrieved from https://ideas.repec.org/a/rom/econmn/v14y2011i1p132-140.html

Power Africa. 2018. Ghana fact sheet https://www.usaid.gov/sites/default/files/documents/1860/Ghana_-_November_2018_Country_Fact_Sheet.pdf

Porcaro, J, Mehta, S, Shupler, M, Kissel, S, Pfeiffer, M, Dora, C, Adair-Rohani, H. 2017. Modern Energy Access and Health. State of Electricity Access Report; Washington, DC: World Bank. http://hdl.handle.net/10986/26648

Sambo, A. 2008. Matching Electricity Supply with Demand in Nigeria**.** *International Association of Energy Economics* (IAEE) Newsletter, Fourth Quarter. Retrieved from https://www.iaee.org/documents/newsletterarticles/408sambo.pdf

Sharrard, A. L, Matthews, H. S, Roth, M. 2007. Environmental Implications of Construction Site Energy Use and Electricity Generation. *Journal of Construction Engineering and Management*, Vol. 133, No. 11, pp. 846-854. **https://doi.org/10.1061/(ASCE)0733-9364(2007)133:11(846)**

Sovacool, B. 2014. Electricity and education: The benefits, barriers and recommendations for achieving the electrification of primary and secondary schools. United Nations Department of Economic and Social

Affairs. https://sustainabledevelopment.un.org/index.php?page=view&type=400&nr=1608&menu=1515#

Tarun K.B, Reaz U, Ambarish M. 2013. Impacts of Electricity Access to Rural SMEs. *International Journal of Managing Value and Supply Chains (IJMVSC)*, 4(4), 17 – 28. DOI: 10.5121/ijmvsc.2013.4402

Talukhaba, A, Phungula, B, Manchidi, M. 2013. Managing the Efficient Use of Energy on Construction Sites and Cost Reduction. Proceedings of SB13 South Africa Conference. Retrieved from https://www.irbnet.de/daten/iconda/CIB_DC26255.pdf

The World Bank Group. (2023). World Bank Global Electrification Database from "Tracking SDG 7: The Energy Progress Report" https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS

Trace, S, Guruswamy, L. (Eds.). 2016. Measuring access for different needs implications. International Energy and Poverty: The Emerging Contours. Routledge, New York, pp. 160–178 https://www.routledge.com/International-Energy-and-Poverty-The-emergingcontours/Guruswamy/p/book/9781138055827

TREIA. 2015. Definition of renewable energy. Define Renew Energy. https://www.treia.org/renewable-energy-defined\

Treloar, G. J, Love, P, Crawford, R. 2004. Hybrid Life-Cycle Inventory for Road Construction and Use. *Journal of Construction Engineering and Management*, Vol. 130, No. 1, 2004, pp. 43-49. **https://doi.org/10.1061/(ASCE)0733-9364(2004)130:1(43)**

Ugwoke, B, Gershon, O, Becchio, C, Corgnati, S, Leone, P. 2020. A review of Nigerian energy access studies: The story told so far. *Renewable and Sustainable Energy Reviews, 120.* https://doi.org/10.1016/j.rser.2019.109646

Uzoma C, Amadi K. 2019. Energy Access: A Key to Rural Development in Nigeria**.** *Journal of Social Science. 5(1), 452 – 456. https://www.rroij.com/open-access/energy-access-a-key-to-rural-development-in-nigeria.php?aid=87509*

Valencia, A, Caspary, G. 2008. Barriers to Successful Implementation of Renewables based Rural Electrification, Briefing Paper, No. 7/2008, Deutsches Institut fur Entwicklungspolitik (DIE), Bonn. Retrieved from https://www.idos-research.de/briefing-paper/article/barriers-to-successful-implementation-of-renewables-based-rural-electrification/

Wagner, C, Seo, S, Aelvarsdóttir, A. 2017. Potential links between electrification and education Ideas for growth (Policy brief). Retrieved from www.theigc.org

World Bank. 2008. The Welfare Impact of Rural Electrification: A Reassessment of the Costs and Benefits – an IEG Impact Evaluation. World Bank, Washington, DC. Retrieved from https://siteresources.worldbank.org/EXTRURELECT/Resources/full_doc.pdf.

World Bank. 2017. State of Electricity Access Report. Washington, D.C. World Bank Group. https://documents.worldbank.org/curated/en/364571494517675149/full-report

https://dergipark.org.tr/en/download/article-file/66570