CONSUMERS' UTILISATION OF SOLAR ENERGY TECHNOLOGIES FOR ELECTRICITY GENERATION IN KOGI STATE

BY

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MTech/SSTE/2018/8798

DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

MAY, 2023

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A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL FEDERAL UNIVERISITY OF TECHNOLOGY, MINNA NIGERIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF TECHNOLOGY IN ELECT/ELECT TECHNOLOGY EDUCATION

MAY, 2023

DECLARATION

I hereby declare that this thesis titled: "**Consumers' Utilisation of Solar Energy Technologies for Electricity Generation in Kogi State**" is a collection of my original research work and it has not been presented for any other qualification anywhere. Information from other sources (published or unpublished) has been duly acknowledged.

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SIGNATURE/DATE

CERTIFICATION

The thesis titled: "**Consumers' Utilisation of Solar Energy Technologies for Electricity Generation in Kogi State**" by: EKELE, Ojonugwa Abraham (MTech/SSTE/2018/8798) meets the regulations governing the award of the degree of (M.Tech) of the Federal University of Technology, Minna and it is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This thesis is dedicated to my beloved parents and siblings for their wonderful support throughout the programme.

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The researcher wishes to appreciate the Almighty God for making it possible to carry out this research project. The researcher also wishes to acknowledge the contributions of several people towards the successful completion of this project and the realisation of his academic aspiration. First and foremost, the researcher is grateful to his supervisors, Dr. S. A. Owodunni and Dr. R. Audu for their advice, professional corrections and guidance. The researcher expresses his gratitude to the following readers; Dr. T. M. Saba, Prof. A. M. Idris and DR. M. Abdulkadir as well as the validates Dr. G. A. Usman, Dr. E. Raymond and Dr. T. M. Saba, for taking out time to read and make necessary suggestions and contribution to the study. The researcher is indeed grateful to all the Lecturers and Administrative Staff of the Deparment of Industrial and Technology Education (ITE), Federal University of Technology Minna among which are the Head of Department; Dr. T. M. Saba, Prof. I. Y. Umar, Prof. B. N. Atsumbe, Prof. Okwori, Dr. A. M. Hassan, Dr. A. B. Kagara, Dr. W. B. Kareem, Dr. D. Ibrahim, Dr. C. I. Igwe and Mr. F. Abutu for the various assistance and kindness rendered at one point or the other.

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ABSTRACT

The study investigated consumers' utilisation of solar energy technologies for electricity generation in Kogi State Nigeria. Five research questions and five null hypotheses guided the study. The study used the sequential explanatory mixed method design. The population for the study was 216,736 respondents comprising of 136,105 household heads, 80,431 Micro and Small Enterprises (MSEs) and 200 licensed electrician in Kogi State. Multi-stage sampling technique was used for the study; cluster, simple random and purposive sampling techniques were used to select 394 respondents for the study. 85 items questionnaire developed by the researcher and validated by three experts was used for data collection. The reliability coefficient of the instrument was determined to be 0.77 through Crombach's Alpha method. Mean and standard deviation were the statistical tool used for answering the research questions; while Analysis of Variance (ANOVA) was used to test the null hypotheses formulated for the study at .05 level of significance. Levenes' test of homogeneity of variances and Tukey's post-hoc test were used to establish the direction of the differences. The analysis of the responses was interpreted in relation to real limits of numbers of the scaling points. The findings on the level of awareness with a grand mean of 3.25 and qualitative data of 90% showed that consumers are aware of solar energy technologies for electricity generation and utilisation; findings on attitudes with a grand mean of 3.08 and qualitative data of 95% revealed that consumers have good attitudes toward the utilisation of solar energy technologies for electricity. Similarly, findings on the perceptions, which had a grand mean of 3.13 and a qualitative data of 90% showed that consumers have a positive perception on solar energy technologies for electricity generation and utilisation. Furthermore, the results on limiting factors with a grand mean of 3.15, revealed that lack of manpower and the necessary technological skills to manage solar energy technologies efficiently are the major factors affecting it utilisation. In the same vein, it was foundout that there was no significant difference in the mean ratings of the responses of the three groups of respondents on all the research questions raised. Based on the findings, it was recommended among others things that solar energy technologies should be subsidized by relevant agencies to encourage mass utilisation; Kogi state government should also commit itself to creating an enabling environment for the private sectors to operate successfully in using solar energy technologies to generate electricity; government should put in place an effective mechanism to check the entry of counterfeits.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the Study

Electrical energy is energy that is caused by moving electric charges. The movement of a charged particle through a conductor is called current, or more commonly, electricity. Electricity is used for both domestic and industrial purposes to power appliances. The importance of electrical energy in the development process of any nation is well known and cannot be over-emphasized. Sambo (2008) noted that suitable supply of electricity is an important factor in the production process and an indispensible factor in social and economic development. Unfortunately, the supply of electricity, undoubtedly, falls short of demand in Nigeria especially in Kogi State and the energy sources for modern world such as solar power is under-utilised.

Solar power is energy from the sun and, it is seen as a good source of energy for many years because of the vast amounts of energy that are made freely available, and because the conventional sources of energy are finite in nature and pose severe threats to man's environment. Wadai *et al.* (2018) sees solar energy as more a sustainable alternative for the supply of electricity if harnessed by modern technology. Sambo (2009) noted that environmental degradation due to energy use and exploitation is already prevalent in Nigeria hence solar energy is a promising renewable energy sources in view of its apparent limitless potential. Also, Sambo *et al.* (2010) held that the massive load shedding experienced all over the nation had made electricity supply only for a few hours a day, implying that the energy supply all over the nation is not adequate for the teeming number of consumers regardless of the enormous potentials presented by the earth's resource system.

The Earth as a resource system has a limited capacity for supporting a growing human population with an intensive exchange of materials and energy with its environment; hence Karlsson (2015) emphasized the need for a growing awareness to achieve a more sustainable societal use of materials to attain a sustainable development and environment. Since energy received directly from the sun is silent, inexhaustible, and non-polluting, Nasir (2016) believes that the utilisation of such energy (solar) using the appropriate technologies such as the solar technologies will lead to a more sustainable living and productivity.

Solar technologies convert sunlight into electrical energy through Photovoltaic (PV) and Concentrating Solar Power (CSP). While PV generates electricity using the conducting properties of certain chemicals most importantly silicon, through the photo-electric effect, CSP make use of reflectors to focus sunlight on a small area, in order to generate steam that powers a thermal electric plant. In addition to electricity generation, solar power is employed to produce thermal energy (heating or cooling, either through passive or active means), to meet direct lighting needs and, potentially, to produce fuels that might be used for transport and other purposes. Since this renewable energy (solar) can be used to generate electricity or be stored in batteries or thermal storage, raising awareness on its enormous potential will have a positive feedback on the larger population so much so that people especially from Kogi State will be able to understand the importance of having renewable energy in their households and in their businesses. These will enable more solar energy used and less carbon emissions which will in turn help the economy and the environment. Thus, Wadai *et al.* (2018) believed that the sun is the most readily and widely available renewable energy source capable of meeting the energy needs of the whole world sustainably. This is because the sun's power reaching the earth is estimated by Hoff and Cheney (2017) to be typically about $1000W/m^2$ and that the total amount of energy that the earth receives daily is $1353W/m^2$. Oji *et al.* (2012a) reported the discovery of David and Hare, (1983) that some 4 million tons of the sun's matter will continue to be changed into energy every second. John and Anthony (2016) found out that the solar radiation arrives at the earth at a maximum flux density of about $1kw/m^2$ in wave length of band between 0.3 and 2.5µm.This is called short wave radiation and it includes visible spectrum. Green (2016) discovered that the habited areas fluxes received vary widely from about 3 to $30MJ/m^2$ per day, depending on place, time and weather. The quality of radiation is characterized by the photon energy of around 2eV as determined by 6000K surface temperature of the sun which can be converted to electricity using solar paneland mirrors that concentrate solar radiation. Since Kogi State, Nigeria is situated at a favourable geographical location, the area stands a high chance of generating enormous electricity from solar energy.

Nigeria is one of the tropical countries of the world which lies approximately between 4^o and 13^o with landmass of 9.24 x 105 km^2 which enjoys an average daily sunshine of 6.25 hours, ranging between about 3.5 hours at the coastal areas to 9.0 hours at the far northern boundary (Bala, 2017). Its climate varies from tropical to subtropical. There are two main seasons; the dry season lasting from October to March and the rainy season lasting from April to October. In the North central Nigeria where Kogi State is located, it is always hot and dry, rainy season extends between April and September. While in the southern Nigeria is hot and wet, rainy season extends between March and December. From December to March there is a long dry season (Ojo, 2014). Temperatures at the coast rarely rise above 32^o C. The north is drier with temperature range between 32ºC and 42ºC. Humidity is about 95% (Falade, 2015). The terrestrial radiation on Nigeria's land area is 2.079 x 1015 kWh/year.

These facts and figures regarding geographical location of the Kogi State clearly revealed that the potential to generate significant amount of electrical energy from solar energy is very high. However, very little has been done in this direction as the government, corporate bodies and individuals are yet to take pragmatic steps towards developing and implementing policies and plans that will serve as a base line on which solar energy utilisation can thrive. This development according to Nasir (2016), is attributed to lack of awareness of solar energy technologies, and as a result vast majority of the people resident in Kogi State rely on electricity supply from the Abuja Electricity Distribution Company (AEDC) which is short in supply and epileptic in nature. The residential sector accounts for more than a third of the electricity used (Conti *et al.*, 2014). Kogi State residential setup includes single-family homes and multi-family housing, and the biggest single uses of electricity in the residential sector are space heating and cooling (air conditioning), lighting, water heating, and appliances and electronics which a small PV and CSP scale can conveniently power but vast majorities of the electricity consumers are unaware of these potentials of solar energy.

Nasir (2016) said that apart from the general knowledge that the sun's radiation is used for drying clothes and food stuffs, majority of the people are not aware about the use of solar technologies to generate electricity, heat water and cook food. This maybe due to little or lack of education or sensitization in this regard. The lack of awareness of the potentials of solar energy for electricity utilisation results to low power supply which undoubtedly have impacted negatively on the economy of the people doing business in Kogi State especially the operators of Micro and Small Enterprise (MSEs).

MSEs are defined in terms of number of employee. Hence Micro Enterprises is between 1 and 9 employees while Small Enterprises is between 10 and 49 employees (Small and Medium Enterprises Development Agency Nigeria & National Bureau of Statistics, 2019). Considering the facts that MSEs plays a big role in the Nigerian economy, and economies around the globe are the ones responsible for driving innovations and competitions in many sectors, using solar energy technologies to facilitating an uninterrupted power supply will bring about positive impacts on the economic performance of the State. Odularu and Okonkwo (2016) stressed that investment into sustainable energy such as solar energy can contribute to economic performance in Nigeria particularly now that Nigeria's economy is experiencing many challenges of trade imbalance, growing competition from developed countries, a collapse of big manufacturing companies and a sharp increase in the cost of doing business owing basically to energy and its related infrastructural costs (Oji *etal.*,2012b). A development which is leading to low patronage of solar technologies and affecting the economy of solar installation electrician in the State. Solar Installation Electricians are responsible for connecting solar equipment, such as panels and inverters to a building's main power supply or to the region's electrical grid. Solar Installation Electricians plan the layout of wiring and features, do voltage testing and ensure that the system complies with all applicable city, county, state, and national codes. Electricians work at homes, businesses, and on construction sites, and generally work as contractors in a growing energy demand society.

The energy demand in Kogi State will continue to increase as the Nigerian population continues to increase and as the energy demand per person increases due to fast urbanization. This means that the pressure on existing energy sources will continue to increase which will negatively impact on the economy around the area. Solar energy provides the right platform to turn the negative trend of epileptic power supply around as solar energy has resource potential that far exceeds the entire global energy demand (Kurokawa *et al.*, 2017; European Photovoltaic Industry Association, 2007). Despite the potential and the recent growth of solar technologies usage in the global market, the contribution of solar energy to the energy supply mix in Kogi State is still negligible (Colgan, 2009). Solar energy technologies could help address energy access for MSEs and domestic use but the challenges of under utilisation due to lack of awareness of the potentials as well as diverse perception and poor attitudes towards utilisation continue to persist.

Awareness is a state of knowing and being informed of something. Hence, awareness level affects the adoption and utilisation of electrical energy behaviour of consumers (Kang *et al.*, 2012). Adoption and utilisation of new solar energy technologies can become a very easy issue if the electricity consumer gains basic knowledge on it limitless potentials. This will drive consumers to pay more attention to solar energy technologies and most probably change their everyday behaviour towards it (Thøgersen & Grønhøj, 2010). Awareness of solar energy technologies is an all important element of electrical energy generation and utilisation, as lack of awareness will leads to under utilisation of the readily available resource and consequently leads to shortage of electricity supply (Choong *et al.*, 2019). Awareness helps to change attitudes. Thus, encouraging users to seek out ways to generate and utilise energy. Hence, attitude of consumers is also a factor that affects solar energy adoption for electricity generation and consumption. Attitude is a way of feeling or acting toward a thing or situation. Attitude towards a behaviour is formed from beliefs about the likely positive or negative consequences of a behaviour. Al-Jubari *et al.* (2019) asserts that the behaviour of individuals is determined by intentions, the antecedents of which are the attitude towards the behavior and subjective norms. Subjective norms are the perception of how a particular behaviour will be viewed by others important to the subject. Perceived behavioural control (PBC) measures a person's perception of her/his ability to perform the behaviour. Claudy and Peterson (2013) applied Behavioural Reasoning Theory in the context of solar consumption among consumers in Ireland and found that the top three reasons for adoption were economic, environmental, and independence, and that the top three reasons against adoption were cost, risk (social and material), and incompatibility (lifestyle and mechanical).

The same type of study was conducted for solar thermal (Schelly, 2010a) with similar results. This has not changed much over time; some of the earliest studies of individuals who owned renewable energy systems (Sawyer, 1982; Tatum, 1990) found that strong environmental values and a desire for economic independence were the two driving motivators for the technology adoption. Hence, much needs to be done to promote the use of renewable energy such as solar using all the technologies available to harness it enormous potentials which will in turn increase electricity used among MSEs operators and residents in Kogi State while maintaining environmental sustainability.

1.2 Statement of the Research Problem

Electricity is fundamental and inevitable to our daily living as it lightens our environment, powers our homes, schools, hospitals, offices, businesses, and promotes industrialization. Stable energy supply is of great importance for the wealth of any society, but unfortunately bulk of electricity in Nigeria and in Kogi State in particular is provided by diesel generators, since the central electricity grid in Nigeria is very unstable with power failure being more rule than exception (Olatunji *et al.,* 2018). Furthermore, Monyei *et al.* (2018) reported that 15.3 million households lack access to grid electricity; and for those connected to the national grid, the supply is unsteady at best. The World Development Indicator rated Nigeria Per capita electricity consumption to be less than 150KW/h in a year (Blancard & Hoarau, 2013). Also, Ebhota and Tabakov (2018) asserted that electricity sector in Nigeria is presently characterized by chronic power shortages and poor power quality supply which has consequently leads to epileptic power supply in Kogi State. Nigerians are climbing down the energy ladder with increased population coupled with diversification of economic activities, energy demand is rising but yet, electricity supply is relatively stagnant (Eleri *et al.*,2020); a situation that has impacted negatively on the commercial activities in Kogi State, stifling the growth of commercial activities and leaving MSEs struggling for survival in the area. Odularu and Okonkwo (2016) identified inefficiency as well as inadequate facilities to boost electricity supply as the major cause of low economic activity.

Epileptic electric power supply had become a common factor in Kogi State (Nurudeen *et al.,* 2018). Such a situation in the opinion of Ikponmwosa *et al.* (2014) should drive individuals, corporate and government organisations to making alternative arrangements to provide electric power for their installations using various forms of renewable energy available for utilisation. This will in no doubt boost electricity supply in the area and consequently increase commercial activities; giving MSEs the platform to thrive and as well curb unemployment in the area.

However, deepening poverty has forced a reversal in the transition to modern and efficient energy forms such as solar energy (Eleri *et al.,* 2020). Sambo *et al.* (2008) believed that lack of exploration of all sources of energy from the available resources is the reason for epileptic power supply in Nigeria. Nkwetta *et al.* (2010) attributed the lack of exploration of other sources of energy like the solar energy to lack of awareness and attitude of electricity consumers on the potency of solar energy technologies for electricity generation and utilisation. It is against this backdrop that this study sought to investitgate consumers' utilisation of solar energy technologies for electricity generation in Kogi State.

1.3 Aim and Objectives of the Study

The main aim of this study was to investigate consumers' utilisation of solar energy technologies for electricity generation in Kogi State. Specifically, the study sought to:

1. Identify the level of awareness of consumers on solar energy technologies for electricity generation and utilisation;
2. Determine the attitudes of electricity consumers on the utilisation of solar energy technologies for electricity generation;
3. Determine the perception of electricity consumers on the utilisation of solar energy technologies for electricity generation;
4. Identify factors affecting the effective utilisation of solar energy technologies for electricity generation;
5. Determine strategies for the effective utilisation of solar energy technologies for electricity ge neration.

1.4 Research Questions

The following research questions guided the study:

1. What is the level of awareness of consumers on solar energy technologies for electricity generation and utilisation in Kogi State?
2. What is the attitude of electricity consumers on the utilisation of solar energy technologies for electricity generation and utilisation in Kogi State?
3. What is the perception of electricity consumers on the utilisation of solar energy technologies for electricity generation in Kogi State?
4. What are the factors affecting the effective utilisation of solar energy technologies for electricity generation in Kogi State?
5. What are the strategies for effective utilisation of solar energy technologies for electricity generation in Kogi State?

1.5 Hypotheses

The following null hypotheses were formulated and tested at .05 level of significant to guide the study.

HO1: There is no significant difference in the mean responses of electrician, residents and MSEs operators as regards the level of awareness of of solar energy technologies for electricity generation and utilisation.

HO2: There is no significant difference in the mean responses of electrician, residents and MSEs operators as regards the attitude of electricity consumers on the utilisation of solar energy technologies for electricity generation.

H_{O3}: There is no significant difference in the mean responses of solar energy technicians, residents and MSEs operators as regards the perception of electricity consumers on the utilisation solar energy technologies for electricity generation.

H_{O4}: There is no significant difference in the mean responses of electrician, residents and MSEs operators as regards the limiting factors affecting the effective utilisation of solar energy technologies for electricity generation.

H_{O5}: There is no significant difference in the mean responses of electrician, residents and MSEs operators as regards the strategies for effective utilisation of solar energy technologies for electricity generation.

1.6 Significance of the Study

The findings of this study will be of great benefit to the government, residents of Kogi States, MSEs operators, dealers of solar energy technologies, electrical power providers as well as prospective researchers.

The findings of the study will reveal the level of awareness, attitude and perspective of the electricity consumers on solar energy technologies used. This will in turn help the government in making sound policy on renewable energy use that will encourage prospective electricity consumers on the use of solar energy technologies and consequently result to enjoying uninterrrupted power supply. It will help the government to see the need to be directly involved in the promotion of use of solar energy technologies in the generation of electricity in the country in order to drive rural electrification with the use of solar technologies especially now at a time when sustainable environment is an issue of concern and the government is promoting rural electrification.

The study presents the need for solar energy as supplementary source of electricity generation and as such full implementations of the recommendations drawn from the findings of this study will be of great benefit to the residents of Kogi State, in a way that the residents will see the need to invest in solar energy technologies as an alternative to the conventional power supply by the national grid and fossil fuel generators which is characterized by epileptic power supply and noise pollution and the released of carbon monoxide (smoke) and enjoy a far more stable supply which is environmental friendly and free from noise pollution and air pollution.

The MSEs operators in Kogi State will benefit immensely from this study because the study presents the need for an improved investment into solar power technologies which will consequently mean an improved power supply for their businesses and that will in turn translate to boost in their business enterprise and making of profits from their ventures. Dealers of solar energy technologies will benefit greatly from this study because through this study, awareness of the benefits of solar power is raised; this will lead to increase in the demand of the technology by prospective consumers and consequently mean improved patronage to the dealers of the technology.

The study point out the needs for diversification and investment into a more sustainable and affordable energy source for electricity generation and as such will be of great benefits to electricity power providers to venture into renewable energy sector which will translate to more profit making to power providers companies. The study also add to existing body of literature and therefore will serve as empirical evidence for students and prospective researchers that want to carry out a similar study.

1.7 Scope of the Study

The scope of the study is delimited to the level of awareness, attitude and perception of electricity users as well as the determination of the limiting factors affecting the effective utilisation of solar energy technologies for electricity generation and suggesting possible interventional strategies for effective utilisation of solar energy technologies for electricity generation. The study however excluded solar heating and cooling (SHC) system. This is because the SHC system collects thermal energy from the sun and uses this heat to provide hot water, space heating, cooling, and pool heating for residential, commercial, and industrial applications and does not generate electricity.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Theoretical Framework

2.1.1 Ecological modernization theory

Ayres and Simonis (1994) propounded this theory. Ecological modernization theory (EMT) argues that advanced states of industrialization result in the potential for environmental values to be used into production practices and policy stances. EMT became increasingly popular in the 1990s, when modern industrial nations initiated action, environment-induced, transformations of the institutional order of society. According to EMT, this institutional action is not merely window dressing but is evidence that ecological modernization can and will occur within the institutional structure of advanced industrial societies. Ecological modernization theorists contend by extension that the use of solar energy technology is yet another step in the process of modernization in capitalist production processes, geared towards ecological sustainability for the sake of both profit and industrial longevity.

The EMT offers theoretical conceptualization of the relationship between industrialization and environmental protection. EMT allows for an analysis of the necessary development of central institutions in modern societies to solve the fundamental problems of the ecological crisis. According to EMT, achieving certain levels of advanced industrialization influences institutional capacity for considering ecological consequences and addressing ecological concerns. EMT contends that at a certain level of modernization, industrial growth and success will require an ecological rationality. Industry will thus consider ecological impact as a major component of any cost-benefit analysis, will minimize environmental externalities, and will increase the efficiency of production to the maximum possible level, all because it will be rational to do so.

The EMT identifies three specific realms of modern society and the relationship between these realms necessary to achieve ecological modernization. According to EMT, both the sociosphere (the social system) and the biosphere (the systems of the natural world) are, in modern society, related to and subjugated by the technosphere (the industrial system of production). An eco-social restructuring of the technosphere, through the process of super-industrialization, is what creates ecological modernization. Ecological modernization, characterized by super-industrialization, allows for industrial, social, and ecological considerations to be weighted equally without jeopardizing the longevity and success of the existing capitalist structure.

The EMT provides a practical theoretical framework for policy development. The theory can be used as a political programme to direct an environmental policy including specific industrial measures and political options for countering environmental problems. This practical side of EMT is evident in the recent political and institutional developments in Western European countries such as the Germany. Furthermore, the application of EMT to practically address environmental problems through advanced industrialization and policy driven outcomes is perfectly applicable to the worldwide increase solar energy technology adoption, which is arguably most pronounced in what EMT could categorize as advanced nations. EMT is related to the present study because it does offer insight into how to promote renewable energy technologies adoption.

2.1.2 Theory of planned behaviour (TPB)

Ajzen (1991) propounded the theory of planned behaviour. The theory asserts that individual's behaviour intention is decided by attitude towards this behaviour, subjective norm and perceived behaviour control. According to the theory, attitude refers to individual feelings (negative or positive) to perform a specific behaviour. Subjective norm refers to individual's perceived pressure from others who are important to him that thinks he should or should not perform the behaviour. Perceived behaviour control refers to the perceived ease or difficulty of conducting the behaviour. Attitude is the first important variable that affects individual behaviour intention in the theory of planned behaviour. The more individual holds positive attitude towards the behaviour the more likely he will intend to conduct this behaviour.

The TPB asserts that subjective norm is the second important variable to affect individual's behaviour intention. Individual tends to comply with the expectation or viewpoints of some important people. In other words, individual behaviour intention might be based on the approval or disapproval of some people that is important to the individual. The higher subjective norm individual perceived, the more likely to perform a behaviour. This is also suitable for solar energy technologies adoption behaviour in domesticity. TPB is related to this study because it can be used to predict individual's pro environmental behaviour in various contexts such as households energy saving behaviour, green products purchasing behaviour and green vehicle adoption behaviour. Therefore, this study is hinged on the Ecolological modernization theory and theory of planned behavior.

2.2 Conceptual Framework

According to Smyth (2004), a conceptual framework is described as a set of broad ideas and principles taken from relevant fields of enquiry and used to structure a subsequent presentation. It is assumed to be a starting point for conceptualizing ideas in the research. Akpabio and Ebong (2010) enumerated the advantages of using conceptual framework in a study to include the provision of a focus to direct the study, improving the researcher's ability with explanation of the relationship between variables of interest when communicating research findings and provision of expanded scope for application of research findings in practice.

The schematic diagram conceptual frame work in figure 2.1 on page 18 presents a pictorial view of how two dependent variables which are awareness and attitudes of electricity consumers (independent variables) on solar energy technologies can lead to solar energy adoption. The figure illustrates that level of awareness which is influenced by the perceived ease of use and attitude to use will bring about the willingness to adopt solar energy technologies for electricity generation and utilisation in Kogi State.

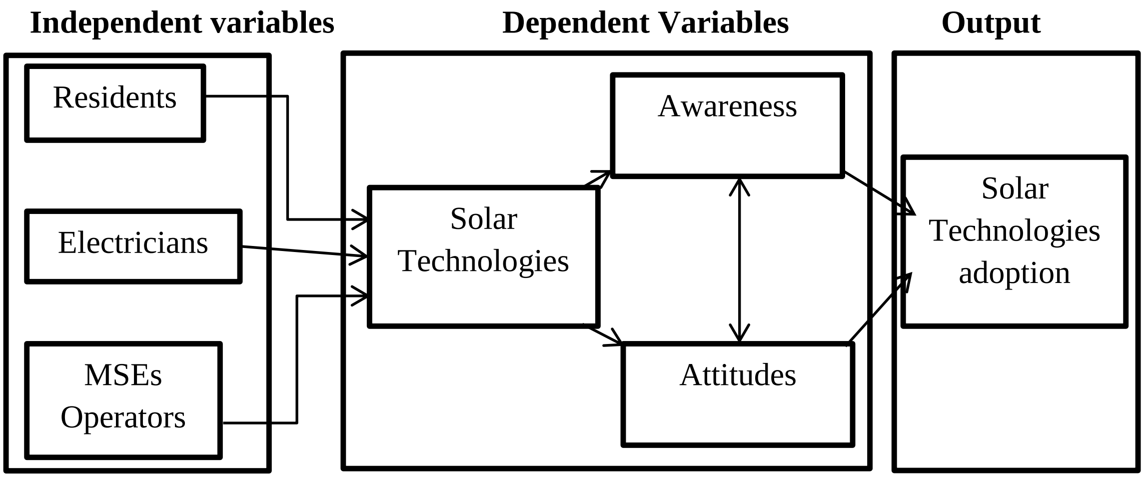

Figure 2.1: Schematic Diagram of a Conceptual Model for Awareness and Attitudes of Consumers on Solar Energy Technologies for Electricity Generation Developed by the Researcher

2.2.1 Solar energy and Nigeria

In one form or another, solar power has been around for thousands of years as a renewable source of free, green energy. Technology has found a way of harnessing the sun's energy via solar panels which are used either to generate electricity (solar photovoltaic) or to produce heat to warm water (solar thermal). Solar technologies is environmentally friendly and as such has become a popular choice in a growing renewable energy market. Solar energy can be seen as the anchor behind various forms of renewable energy.

It anchors hydro power where the hydrological cycle is being controlled by the sun as well as Wind Power where the movement of air is due to the heating effect of the sun on the atmosphere. In general, heat, kinetic energy, electrical energy and chemical energy can be provided via solar energy conversion (Tyagi *et al.*, 2013). In theory, solar energy can be perceived as an ideal energy source, because it is free and virtually limitless.

However the technological barriers with regards to its collection, distribution and storage are great. Solar energy forms the basis or acts as the source of all other forms of energy on earth. Hence with the increase in intensity of solar radiation reaching the earth, it is paramount that this invaluable resource be put into adequate and efficient use in various areas of life. Solar energy utilisation takes its root in the early ages when solar energy (sun) was used as a clock, as a compass and for preservation of food . In this modern age we have simply improved upon the findings of the old to get greater value, efficiency and time saving. To this end, solar energy is ever growing and ever expanding in its utilisation. Many literatures have attested to Nigeria's geographical advantage in use of solar Photovoltaic (Adurodija *et al.*, 1998; Sambo *et al*., 2010; Ohunakin *et al.,* 2014).

The country's sunshine hours of 4 to 7.5hrs/day (Sambo *et al.,* 2010), and average daily solar radiation ranging from 14.4 to 21.6 MJm-2/day have been noted to have the capacity to sufficiently meet domestic electricity demands (Mohammed *et al*., 2013). Also, the Energy Commission of Nigeria (ECN), the apex government organ for formulation and monitoring of energy policies has reiterated in many of its publications, the capability of solar PV technology to meet the nation's electricity demands (Sambo, 2005; Bala, 2012). Nigeria, having a land mass of 923,768sq.km, is situated in the West African region and lies between longitudes 3 degrees and 14 degrees and latitudes 4 degrees and 140 degrees (Nigeria Embassy, 2013).

Nigeria receives abundant sunshine all the year round being just above the equator. However, very little has been done in this direction as the government is yet to take pragmatic steps towards developing and implementing policies and plans that will serve as a base line on which solar energy utilisation in Nigeria can thrive. (Ohunakin *et al.,* 2014).

Three different solar radiation zones can be identified in Nigeria: zones I, II and III with each zone having different radiation levels that may be needed for a particular project selection and sizing (Ohunakin *et al.,* 2014). Zone I comprises of all the states in the North-East geo-political zones (Borno, Yobe, Jigawa, Kano, Kaduna, Bauchi, Gombe, Adamawa, Plateau and Katsina) with the high solar radiation incident on the horizontal surface, the country has excellent and viable potential for large scale solar photovoltaic (SPV) especially in the semi-arid region. Zone II consisting of the North-West and North-central belt of the country (Sokoto, Zamfara, Kebbi, Niger, Abuja, Nassarawa, Taraba, Kwara, some section of Plateau and Katsina); also have viable solar radiation that may be required for most solar projects. Low potential of annual global solar radiation exist in zone III (comprising all locations in the South region of the country including the coastal region) Oyo, Osun, Ekiti, Kogi, Benue; zone III can be suitable for stand- alone PV systems. Furthermore, some states/locations in the South-West and South-East regions can readily support decentralized solar energy projects (Ohunakin *et al.*, 2014).

2.2.2 Converting solar energy to power

Solar energy works by capturing the sun's energy and turning it into electricity using the instrumentality of the solar panel and mirror as shown in figure 2.2 and figure 2.3. The sun is a natural nuclear reactor. It releases tiny packets of energy called photons, which travel the 93 million miles from the sun to Earth in about 8.5 minutes (Pallikkara & Ramakrishnan, 2021). Every hour, enough photons impact our planet to generate enough solar energy to theoretically satisfy global energy needs for an entire year**.**

The major components for harnessing electricity from solar are panels in case of photovoltaic and reflectors (mirrors) in case of CSP. Electricity can be generated directly from solar energy by solar cells. A collection of solar cells makes a panel which is the unit commonly found in the market. The collection of these panels is called a solar array. According to Fraas (2014), the most popular solar panels found today are made of polycrystalline silicon, mono-crystalline silicon, amorphous silicon and thin film silicon. The panels are usually mounted on roof tops, poles or free standing on ground and should be free from obstruction, as shadow covering one-fourth of panel can reduce its output by up to 50%. It is very important to mount solar panels and reflectors at the right angle and orientation. The use of solar trackers increases the efficiency of the system. Further, loads factors should be properly ascertained in order to obtain the accurate required configuration.

A complete solar PV system consists of the panels, inverters, batteries and charge controllers. The solar panel converts solar energy to DC electricity, while inverters are needed to convert the DC electricity to AC electricity which most electrical appliances utilize. The batteries are used to store electricity during the day for use during periods of little or no generation which is mostly at night. The charge controllers regulate how the batteries are being charged and discharged. Thus providing protection for the batteries. Solar PV system can be grid-tied or off-grid. In grid-tied system electricity is generated during the day and fed into the grid system directly. Off-grid SPV system is the most popular. It is mostly used for remote location far away from the grid where extending the grid to such location is not economically viable. The system is not connected to grid but directly fed to final consumers. Excess electricity is stored in batteries for use at night. The solar cell typically has an efficiency of 9-16% and can last for25 years.

The photovoltaic (PV) solar energy system is shown in figure 2.2

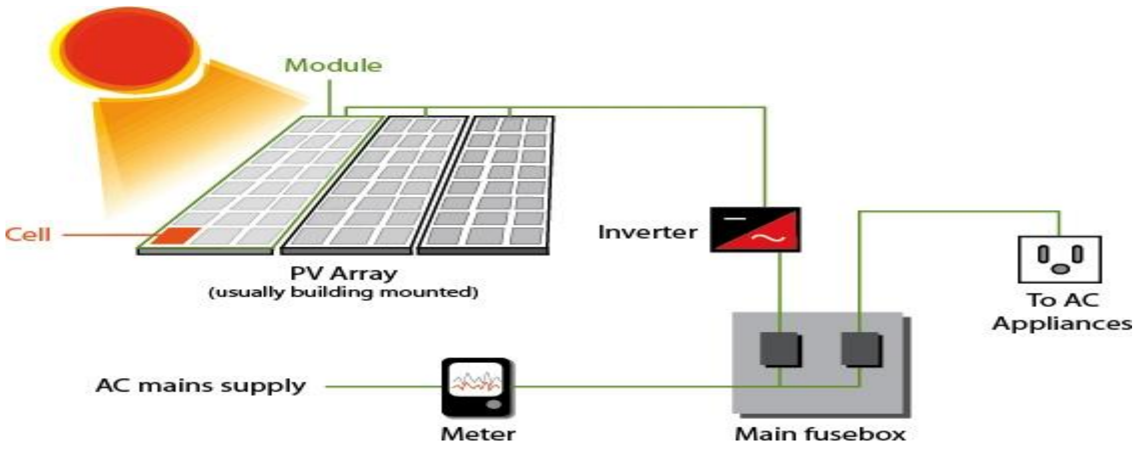

Figure 2.2 Photovoltaic (PV) Solar Energy Systems
Source: https://www.designnewhouse.com/solar-energy (2021)

Concentrating Solar Power (CSP) technologies use mirrors to concentrate (focus) the sun's light energy and convert it into heat to create steam to drive a turbine that generates electrical power. The process of generating electricity from CSP is nearly the same with conventional fossil fuel thermal plants with the difference being the fuel source.

A typical CSP plant uses reflectors and parabolic mirrors to focus the sun’s rays onto a heat collector (ElGharbi *et al.,* 2011). Heat transfer fluids such as synthetic oil are used to transfer heat from the collector to heat exchangers where water is super-heated. The super-heated steam runs a turbine which in turn drives a generator to generate electricity. According to Singh *et al.* (2018), there are different CSP technologies based on focus type (line and point focus) and receiver type (fixed and mobile). Thus, there is line focus fixed receiver, line focus mobile receiver, point focus fixed receiver and point focus mobile receiver. Most CSP technologies use thermal storage in which excess heat is diverted to storage material such as molten salts. After sunset the molten salt is used as heat transfer fluid for the system. Thermal storage ensures that the turbine can always run at full load and with optimal efficiency, which in turn makes the power plant more profitable. CSP systems are ideal for grid connection, although small off-grid systems can be designed; they are the best suited solar technology that is capable of providing utility scale electricity and are usually used to provide base load power where they exist.

The Concentrated Solar Power (CSP) Systems is shown in figure 2.3

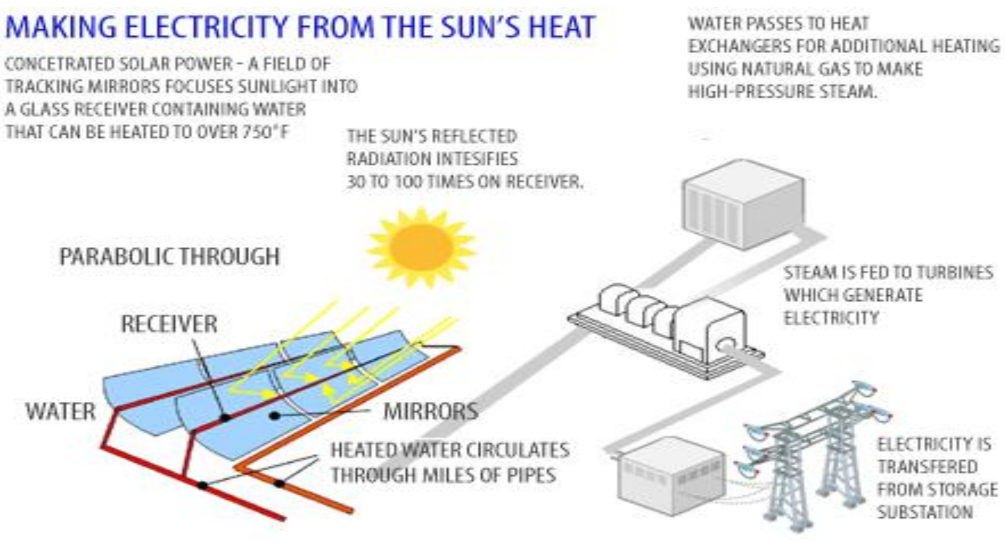

Figure 2.3 Concentrated Solar Power (CSP) Systems

Source: http://solarenergyfactsblog.com/solar-energy-diagram (2021)

2.2.3 Nigeria's solar pv and csp potentials

Nigeria lies within a high sunshine belt and thus has enormous solar energy potentials. It has an average daily sunshine of 6.25 hours, ranging between about 3.5 hours at coastal areas to 9.0 hours at far north. The country has an average of about 5.25 kWh/m^2 per day of solar radiation annually, varying from 3.5 kWh/m2/day in the coastal latitude to 7.0 kWh/m2/day in the far north. Nigeria receives about 4.851x 1012 kWh of energy per day from the sun, (Ani *et al.,* 2012). This is equivalent to about 1.082 million tonnes of oil equivalent (Mtoe) per day. Based on the land area of 924 x 103 km2 for the country and an average of 5.535 kWh/m2/day, Nigeria has an average of 1.804 x 1015 kWh of incident solar energy annually. This annual solar energy insolation value is about 27 times the nation total conventional energy resources in energy units and is over 117,000 times the amount of electric power generated in the country. In other words, about 3.7% only of the national land area is needed to be utilised in order to collect from the sun an amount of energy equal to the nation's conventional energy reserve, (Okafor & Joe-Uzuegbu, 2010).

2.2.4 Solar energy projects in Nigeria

Based on the 1999 national survey by the Nigeria Energy Commission, there are a total of 33 companies that were active in Solar PV by then, with over 200 solar PV installations, in the country as at 1998, with capacities ranging from 3.5 to 7.2 kWp (Energy Commission of Nigeria, 2008). The Solar Electric Light Fund (SELF), an NGO based in USA. Jigawa State Government initiated a proposal to bring solar-generated electricity (PV) to power essential services in 3 villages of Jigawa State in 2001 (Chendo, 2002). Research done by Awogbolomi and Komolafe (2011) indicated notable solar energy projects in Nigeria to include: Street lighting in Ado Ekiti, Ekiti State; 7.2kWp Kwalkwalawa Village Electrification, Sokoto State; 1.87kWp Iheakpu-Awka Village Electrification/TV Viewing, Enugu State; 1.5kWp Nangere Water Pumping scheme, Sokoto State; 2-tonne Solar Rice Dryer, Adani, Enugu State, and 1.5-tonne Solar Forage Dryer, Yauri, Kebbi State.

Other new investments in the solar energy sector in Nigeria include; 1. 50 MW solar farms in Kaduna State by the Synergent Group, 100MW solar farm in Bauchi State by the Nigeria Solar Capital Project and Gigawatt Solar, 60MW in Katsina State by the Nigeria-German Energy Partnership, 20MW solar energy plant owned by Katsina State.

These projects are aimed at reducing the acute energy poverty in Nigeria, reduce greenhouse gas emission from use of diesel generators, and enhance sustainable energy use in Nigeria. In 2013, President Goodluck Jonathan inaugurated the "Light-Up Rural

Nigeria" in Durumi Community, Bwari Area Council, Abuja with the intent that renewable energy will be used to generate electricity for rural communities, especially areas not connected to the national grid in all the 36 states of the federation (Premium Times, 2013). In the year 2013, SkyPower FAS Energy entered into agreements with both the Federal Republic of Nigeria Government and the Delta State Government for the setting up of utility-scale solar photovoltaic (PV) projects totaling 3,000MW within Nigeria and Delta State. The project was set to be developed within five years and will lead to the production of clean, sustainable and cheap electricity that will meet the growing energy needs of Nigerians.

2.2.5 Perception and awareness of the public towards solar energy utilisation

Public opinion of different energy sources especially solar energy is critical for the planning of future energy development. The public has an active role to play in the development of energy policy and operation of the energy market. However, in developing nations, studies involving public opinion on renewable energy are lacking. Global studies that attempt to identify the level of public awareness, acceptance, and attitude towards different forms of energy technologies have been conducted. According to Van Rijinsoever and Farla (2014), public acceptance is becoming more prominent, due to the development of societies where scientific information is more accessible to the public.

Furthermore, with most new sustainable energy technologies being funded by public resources, their opinion remains critical for successful implementation of energy development. Karytsas and Theodoropoulou (2014) concur that public awareness of renewable energy sources can contribute to social acceptance and improvement in consumer energy behaviour. Assali *et al.* (2019) demonstrated a strong relationship between renewable energy implementation and public awareness, policy structure and market characterization. Studies on public perception and knowledge about energy-related issues often assist policy makers and stakeholders in pursuing sensible policies to meet public concerns. With many emerging economies expressing interest in adopting cleaner energy alternatives to counter fossil fuel consumption, it is critical to assess public perception on renewable energy development issues. Most literature on renewable energy development tends to focus mostly on the technological and power supply aspects of renewable energy, with few studies investigating the public perspectives of renewable investments. Hence, there is the need for public input to guide the development of appropriate renewable energy technologies.

To the best of the researcher's knowledge, few studies involving assessment of public perception on solar energy have been conducted in Nigeria. An example is a study by Akinywale *et al*. (2020), assessing public understanding and attitudes of renewable energy resources. They stressed the need for research that uses both qualitative and quantitative approaches to assess symbolic, affective, and discursive nature of beliefs about renewable energy technologies. In a separate study investigating public perceptions about renewable energy technologies in Nigeria, Wojuola and Alant (2017) found positive correlations between perceived usefulness, and ease of using renewables. Similarly, Nwachukwu *et al.* (2014) highlighted awareness and information gaps as the major barriers limiting development of solar PV in Nigeria. The study delineated the need of formal and informal energy education in the country.

The study conducted by Jain *et al. (*2016) on rural electrification through solar energy, revealed that awareness level of the beneficiaries was very low. Similarly, Wani and Pandya, (2016) conducted a survey to investigate the perception of engineering students in Vadodara city to understand their perception about solar energy. A questionnaire was filled up from students to study the awareness and interest of students in solar field. From the results, it was observed that students do not possess any knowledge regarding the solar policies and solar technologies. Students from engineering colleges are aware about the solar energy and its advantages; they are environmentally conscious regarding use of solar. They desire to undertake solar projects but they are having limited knowledge of solar technologies. They don not have any on hand experience in developing the solar system.

Wapner (2015) conducted a renewable energy (RE) Survey to understand people's perception on solar energy and determine the level of acceptability among Indian citizens of the use of solar energy. The survey was conducted under two categories: Individual awareness survey and manufacturer's survey. The study reveals a favourable case for solar adoption and expansion. Over 90 per cent of the individuals agreed that solar energy contributes to a greener lifestyle and more than 95 per cent non-users of solar technologies are willing to adopt solar technologies in the future. There is tremendous scope for development of solar energy applications in the country. According the study, the biggest barrier to promoting solar energy technologies are the various myths and misconceptions that inhabit the minds of prospective adopters. The most common of them is that renewable energy is very expensive and unable to meet the energy demands. The study also reveals that awareness about government policies and incentives regarding renewable energy is very low among the people.

Venkatraman and Sheeba, (2014) conducted a study on customer's attitude towards solar energy devices. The study examines the customer's attitude, preferences and their views about the features and usage of solar energy devices and their evolution in the market trend. The survey was conducted with the help of questionnaire. It was observed that people are aware of the benefits of usage of solar energy. They buy solar products for its durability. Most of the respondents are satisfied with the solar water heaters, solar batteries and solar inverters. 43% respondents think that it has high installation charges. Majority of them thought that the main advantage of solar devices is its infinite energy source. Few respondents 37% think that there is a problem of climate variations in solar energy devices. Also, Prasanna *et al.* (2014) conducted an overview of public perception about the suitability of solar power panels as an alternative energy source in Andhra Pradesh to know the usage levels of solar panels at present, along with the opinion of people about the solar panels, the prospects of solar panels, and the ways to approach various types of customers. It considers the factors related to availability, inhibitions and branding of solar panels. The survey was conducted with the help of questionnaire. From the findings it was observed that everyone is facing the problem of power cuts mostly in rural region. So people from rural areas have shown more interest in solar system. People are ready to buy the solar system if available in education management information system (EMIs). Mostly people are unaware of the subsidies offered by the government. They feel that the maintenance of solar panel is very high.

In the study conducted in and around Chennai (Vajayanthi, 2013) says that there is sufficient awareness of people towards solar energy. People are environmental conscious and are interested towards solar energy for domestic use. They believe that solar energy is environmentally friendly and saves money. The study also revealed that there is relation between public income and interest towards solar energy.

2.2.6 Consumer's attitude on the utilisation of solar energy for electricity generation

Claudy and Peterson (2013) applied Behavioural Reasoning Theory in the context of solar consumption among consumers in Ireland and found that the top three reasons for adoption were economic, environmental, and independence, and that the top three reasons against adoption were cost, risk (social and material), and incompatibility (lifestyle and mechanical). The same type of study was conducted for solar thermal (Schelly, 2010b) with similar results. This has not changed much over time; some of the earliest studies of individuals who owned renewable energy systems (Sawyer, 1982; Tatum *et al.*, 1990) found that strong environmental values and a desire for economic independence were the two driving motivators for the technology adoption. Those studied in these early surveys exhibited a great deal of knowledge on renewable energy and were willing to pay a premium to install projects.

Further research has found that those with more knowledge of environmental issues will have a higher willingness to pay for green technologies (Lee, 2011). Claudy *et al.* (2011) further explored willingness to pay for solar electric, solar thermal, wind energy, and biomass systems, finding that knowledge and other rational decision-making factors do not stand alone, but are influenced by other cost-benefit evaluations, perceptions of each technology, and social norms. Kaiser and Schultz (2010) tested three models of the attitude-behaviour with regards to environmentally-beneficial actions to assess difficulty as a moderating factor, but their results were inconclusive. Attitudes toward various characteristics of solar power systems are isolated to determine which characteristics are preventing the pragmatic early majority from adopting solar power. Therefore some of identified barriers in the UK context are poor aesthetics, high cost, insufficient government grants for solar power purchase, too much maintenance required, does not add value to property, difficult installation (Faiers & Neame, 2006). Liu *et al*. (2013) examined rural social acceptance of solar energy deployment taking Shandong in China as a case study via a field questionnaire survey. They adopted the theory of planned behaviour to establish an analytical framework, and a logit model was used to examine possible determinants of local social acceptance. The results of their study show that rural residents are generally in support of renewable energy development given its positive impacts on environment, and that the public willingness to pay more for renewable electricity is positively related to household income, individual knowledge level and belief about costs of renewable energy use but negatively related to individual age. Maklad (2014) concluded in his study that Australia is highly motivated to focus on domestic micro electricity generation from solar energy for domestic buildings considering the historical and current ongoing economic aspects relevant to Australian households. Kaldellis *et al*. (2012) also conducted a study on the public attitudes towards renewable energy applications in Greece. A questionnaire was deployed for conducting the survey based on a representative sample of local inhabitants. The results showed that there is high level of knowledge and acceptability of solar energy applications in southern region although the need for additional public information regarding RES exploitation has also been designated.

Recent studies also have indicated two major factors that tend to determine a customer's adoption of solar panel systems: financial incentives and non-financial reasons. Financial incentives include financial supports provided by central and regional governments. Naveen *et al.* (2012) provided empirical evidence to show that government initiatives and institutional finance can strongly affect the adoption of solar PV power supply systems in developing countries such as India. Richter (2014) concluded that micro-generation technologies are diffused mainly in countries that provide incentives to support installation. Research shows that government policies' design and implementation influence customers' decisions about the adoption of SPS as well as the SPS market's outlook. Jing and Yugao (2005). found that the incentive policy played an important role in attracting more social media and enhanced the market competitiveness of grid-connected solar PV systems in China.

Chemi and Kentish (2007) examined the potential effectiveness of the renewable energy policy in China and its regulatory law framework, and identified the types of shortcomings that have interfered with more successful expansions of renewable energy in China, based on primary data collected from interviews with stakeholders. Rogol (2007) reported that the rapid growth of Japan's solar power sector was enabled by the interplay of several factors: (a) the extrinsic setting (including the solar resource, interest rate, and grid price), (b) industrial organisation (including the structure of the electric power sector and the structure within the solar power sector), (c) demand-side incentives that drove down the "gap" and provided a "trigger" for supply-side growth, and (d) supply-side expansion that enabled significant reductions in costs, which more than offset the decline in demand-side incentives. Sawin *et al.* (2010) concluded that the PV manufacturing sector of China flourished due to the availability of low-cost loans. Gallagher (2014) showed how government, through market-formation policy, can unleash global market forces. She pointed out that finances presented an obstacle to the development and deployment of cleaner energy technologies, such as SPS, and argued that the biggest barrier is the failure of government-subsidized traditional technology. Non-financial reasons affecting adoption of PV include social or peer influences (Beiley *et al.*, 2011), attitudes about innovation (Chen, 2013), and environmental preferences (Bollinger & Gillingham, 2012). Kaplan (2005) first identified the importance of customers' technical knowledge, motivation, experiences, and familiarity influencing their interest in PV. Faiers and Neame (2006) explained that environmental concerns affect household PV system installation, along with other adoption factors such as financial status, economic concerns, and aesthetic characteristics. Islam and Meade (2013) discussed how the lack of information about the new technology slows the adoption of micro-generation technology using renewable energy. Solangi *et al.* (2012) suggested that the government should increase use of solar energy, while colleges and graduate schools should promote research in solar energy. Li *et al.* (2013) used surveys to test farmers' purchasing desire as related to certain factors. They showed that concerns about quality of life, government incentives, and word of mouth (favorable comments from friends and neighbors) have significant positive impacts on farmers' willingness to convert traditional houses to solar houses in rural areas. Additional monthly out-of-pocket expenses and switching costs have significant negative impacts. Durability of the system, popularity of PV, timing, and the local solar market's maturity had no significant impacts. Richter (2014) explained that the local environment could influence the social effects on the household PV installation. There are few papers discussing the adoption of solar energy in urban areas in China by examining primary data. This paper reports on surveys and analysis of the attitudes of Chinese citizens toward purchasing decisions regarding residential solar PV systems.

2.2.7 Advantages of solar energy utilisation

Solar energy utilisation for generating electricity no doubt has several advantages. Oji *et al.* (2012a) elucidate the following advantages: low operational and maintenance cost, a very high meantime between failures of about 20-30 years, noiseless and no moving parts during operation, availability of PV panels in different sizes or modules over a wide range of power rating, perceived environmental friendly nature with respect to release of greenhouse gases, global warming, ozone layer depletion,

Despite some of the advantages of solar energy utilisation highlighted above, solar technology is not without challenges. Some of the challenges affecting solar PV and CSP development in Nigeria include higher initial investment cost as compared to conventional plants of same output, lack of indigenous manufacturing companies; lacks of trained personnel to installed and maintain existing equipment. Low system efficiency compared to conventional plants. There is little or no generation at night or on cloudy days coupled with lack of adequate storage technology. Since majority of Nigeria's population are poor (NBS, 2012), only very few will afford to buy/install solar PV devices. It has been reported that an estimated 54 per cent of the Nigeria's population live below the poverty line (43 per cent urban, 64 per cent rural), and 90 per cent of the poorest people live in the north (Nwofe, 2014).

Another contributing factor is the lack of manpower and the desired technological skills. Currently in Nigeria, solar PV devices are only imported and this will increase the cost of investment, also little is known about the use of CSP technologies for generation of electricity, hence utilisation of the technology is hampered. Furthermore, the absence of equipped laboratories/research centres for solar PV research has contributed immensely to the scarcity in the effective use of the technologies. High illiteracy rate in Nigeria is another serious and important factor. Recently, the Minister of State for Education in Nigeria noted that adult illiterates rose from 25 million in 1997 to 35 million in 2013 (Nwofe, 2014). This makes the focus of most citizens to be on the ease of fhing free fuel wood for their domestic needs without consideration on sustainability of the environment and climate or on the health implications. Low levels of awareness also contribute a significant quota. The level of awareness on the huge health, socio-economic and environmental benefits derivable from solar energy is very low in Nigeria. The current trend of information concerning the development, applications, dissemination and diffusion of solar energy resource and technologies is grossly inadequate and should be stepped up through; the media, mobile networks, schools . Lack of effective National Energy Policy is another factor of concern. Although there are many Government policies regarding the adoption of renewable energy, clean energy technology, diversification of energy-mix, and energy efficiency, implementation of such policies is either to slow or deadlocked after appearing in newspaper headlines or news commentaries. Other authors have discussed similar scenarios (Okey, 2013., Oji *et al.*, 2012b, Uduma & Arciszeswki, 2011., and Bala *et al.*, 2000). It is also worthy to mention that absence of establishment such as renewable energy data recording stations amongst others impose serious setbacks on the research and applications of renewable energy related products. Other factors affecting effective solar energy utilisation has been highlighted, these included:

i. Long energy pay-back time

In the review of the life cycle assessment of solar PV based electricity generation systems carried out by Sherwani *et al*. (2010), the variation in the energy pay-back time (EPBT) and greenhouse gas (GHG) emissions have been dependent upon many factors, such as the type of solar cell, solar panel orientation and angle, irradiation of the location, difference installation (integrated or non-integrated systems as well as facade, flat roof and solar roof tiles), efficiency of the Balance of system (BOS) components, size (capacity) of the system, lifetime of the system and the electricity mix of that particular country and year of study. The main issue that arises from this is that EPBT influences the decision of investors to invest in electrical energy generation using PV panels. If investors perceive the EPBT in solar PV based electricity generation systems to be too long, they may decide to seek for alternative investments which will hinder the growth of the Solar PV electricity generation Industry. It is therefore necessary that the energy pay-back time of solar PV based electricity generation systems be reduced considerable through continuous improvements in designs to facilitate production of PV cells that are cheaper and yet have higher efficiencies.

ii. High up frontal capital cost

Another major down side of solar energy utilisation in generating electricity is the high up frontal capital cost compared to its conventional energy alternatives (Chigbo, 2010). The general perception is that this technology is not yet mature hence it is only suited for particular markets and even then will require heavy subsidy to make it viable. This is quite erroneous to some degree as many countries such as Germany, the United States and China have succeeded with their solar energy utilisation plans and are already enjoying the numerous dividends (Tyagi *et al.*, 2013). Solar voltages have been powering space modules since the beginning of space programmemes and talking about the cost, the high up frontal capital cost can be handled by letting Giant companies and Governments play a part in the programmeme by bringing in the much needed up front capital and recouping their investment over time.

iii. Ignorance of the benefits of the technology

Another serious setback to the solar energy programme is ignorance of the benefits of this technology. Awareness of the opportunities offered by solar energy and its technology is low among members of the public and private sector stakeholders. This lack of information and awareness creates a market distortion that results in higher risk perception for potential renewable energy projects.

Energy conservation interventions have frequently failed because they often did not take the full range of significant influences on human behaviour, into account (Kok *et al*., 2011), There is therefore a need for dissemination of information on solar energy resource availability, benefits and opportunities to the general public in order to raise public awareness and generate activities in the sector. Kenya has taken giant steps in the number of solar power systems installed per capital (but not the number of watts added). More than 30,000 very small solar panels are sold in Kenya annually, as more Kenyans adopt solar power every year than they make connections to local grid.

iv. Requirement of large expanse of land

Another major issue in the use of solar PV panels is the large expanse of land required for their installation. Clearly, moving to solar energy as a major energy producer would mean an enormous reallocation of land and resource use. However with the continuous improvement in PV efficiencies, the required space per Kwh of electricity generated will continue to be on the decrease.

v. Low efficiencies of PV panels

Low efficiency of PV panels is another draw draw-back presently limiting the widespread diffusion and usage of PV cells in generating electricity. PV panel efficiencies must be increased to establish their acceptance in the energy market. It is believed that exploiting the multi junction technology will provide the future PV panels with higher efficiencies. PV panel efficiencies and output power decreases due to increase in temperatures hence the need to provide cooling at high illumination conditions. Dust and humidity also reduce the efficiencies of solar PV cells to lower values.

Sambo (2006) also identified and mentioned other factors that hinder the growth and use of solar energy in Nigeria to include:

vi. Lack of capacity and standard quality control

The lack of capacity and inadequate expertise that must be developed, and manage the renewable energy sources better managed because the nation rely exclusively on outsourcing expertise for management of the little renewable energy sources it utilizes. There is inadequate infrastructure which makes the renewable electricity components scarce; this makes the country rely totally on imports of components for the maintenance of renewable energy electricity. Another major barrier to the development of alternative sources of energy market in the nation is the lack of established standard and quality control systems of both locally and imported manufactured technologies. Quality assurance builds consumer confidence in the new and growing market of renewable energy. The important things of standard and quality control include the perception of the potential users, bad developed regime for setting standards, certification and testing as well as professionalism among the operators and service providers.

vii. Financial and fiscal incentives

The Nigerian energy policies on financial incentives focus mainly on centralized and conventional sources of electric power. The incentives that were established are to encourage investments in power generation that are conventional. A government subsidy on the grid power discourages and penalized investment in renewable energy solutions. There is no any government policy that gives financial support and incentives that will help the and fast track the growth of renewable energy, and also develop demand and supply of the renewable energy market in Nigeria. Financial and fiscal incentives have a great impact in the development of renewable energy in Nigeria because it will indicate government willingness and commitments of diversifying the source of energy from total reliance on fossil fuels which is one of the key factors that is affecting the Nigerian energy sector. This lack of a level playing ground for alternative energy sources and technologies has great impact to the growth of solar energy in Nigeria.

viii. Deregulated and liberalized energy industry

Nigerian energy sector is controlled exclusively by the government and this is one of the key factors that hinder the growth of the renewable energy sector in Nigeria, because there is no adequate institutional framework. In addition, there is no agency that is responsible for issuing licenses to companies that will provide smaller capacities of renewable energy electricity. This has also limited the penetration of renewable energy firms into the Nigerian market.

ix. High initial investment cost

Renewable energy is quite expensive which makes the electricity generated from the system to have high initial cost, which as a result limited the penetration of the renewable energy electricity system into the Nigerian market in consideration of the level of income of majority of the population. Small scale hydro power, residual and central solar PV technologies have not penetrated the energy supply systems in Nigeria because of their high investment cost. This has been identified as one of the key factors that are affecting the growth of renewable energy technologies in Nigeria and the widespread adoption of family-sized biogas digesters in Nigeria.

Renewable energy have high initial investments cost, this have great effects on renewable energy projects and the total cost of the energy produced per KW-h. Potential investors in renewable energy in Nigeria are not favourably disposed to small hydro, wind or power that is generated from cogeneration plants if is not profitable. The average electricity tariff in the nation is put at about #6:75 per KW-h (which is approximately 5 cents per KW-h). Typical sources of renewable power for small hydro is averagely 5-10 cents; solar PV: 20-40 cents, wind power: 6-10 cents, biomass power: 5-12 cents. Without good financial support it will be difficult to enter into renewable energy market in Nigeria.

2.2.8 Strategies for effective utilisation of solar energy

Utilisation of solar energy are critical and important steps to attaining energy availability, efficiency and sustainability in developing economies fortunate to be endowed with such natural and abundant resources like Nigeria. For effective and efficient utilisation of solar energy in Nigeria, Nwofe (2014) strongly recommends that: government should subsidize the cost of importation of solar PV devices; government should do more to eradicate or reduce poverty to the barest minimum; government should step up her campaign on reduction of illiteracy in Nigeria; extensive research in biomass and solar energy should be given special attention by Government; introduction of renewable energy incentives similar to the “feed-in-tariffs” by Government will enhance increased consumption of renewable energy related products; provision of soft loans by financial institutions, and financial assistance to individuals by government and non-governmental organisations; increase in the level of awareness on the merit of investment of consumption of renewable energy products, and finally more research centres on renewable energy technology should be established and existing ones to be equipped properly.

In another study, Oji *et al*. (2012a) believed that for effective and efficient utilisation of solar electricity in Nigeria, more research into the techno-economies involving the initial and subsequent costs of solar plants and their power efficiencies is needed. Oji *et al*. (2012a) recommended the following: government should subsidize the cost of importation of Renewable Energy Technologies (RET) most especially solar PV to bring down the high cost in Nigeria; private individuals and organisations should be encouraged by appropriate authorities to invest in solar technologies in the country; the wide chasm between research bodies (universities, polytechnics and research institutes) and manufacturing industries must be bridged; government should create more awareness on the advantages derivable from Renewable Energy Technologies (RET) such as solar technologies; government can also consider placing restrictions on the importation of diesel and petrol engine generators because of its adverse effects on the environment even as the global community gear towards clean (green) energies; funding of solar technology researches and development initiatives in Nigerian Universities, Polytechnics and Research Institutes so as to develop solar PVs with increased efficiency that will be adaptable to our environment is advocated as is obtainable in developed countries.

2.3 Review of Related Empirical Studies

Lawal (2010) conducted a study on Renewable Energy as a Solution to Nigerian Energy Crisis. The main aim of the study was to investigate the potentials of renewable energy sources in Nigeria and how to support, promote and encourage the growth of renewable energy resources in Nigeria to close the gap of 60-70% of Nigerians that did not have access to energy that is environmentally friendly. The study used the sequential mixed method design. The data was collected using both qualitative and quantitative research method. A structured questionnaire and interview was used for data collection on the various research questions raised by the researcher. The population of the study was 160 Nigerians. Purposive sampling was used to obtain the sample size for the study. Four research questions were raised and four hypotheses tested. Data collected was computedusing SPSS version 20. Mean and standard deviation were used to answer research question while t-test was used to test hypotheses at 0.05 level of significance. Finding of the study revealed that the demand for electricity in Nigeria is very high; however, the supply is not adequate and constant to meet the demand which left many Nigerian citizens with no options than to be using privately owned conventional energy power generating systems. The use of the conventional power generating systems is very costly and also is not environmentally friendly. The potential of renewable energy resources in Nigeria is put at excess of 1.5 times that of fossil energy resources, in energy terms. Solar, wind, hydro and biomass have significant potentials to improve and make a difference on the low level access of electricity in Nigeria, with emphasis on the rural areas, through the adoption and the use of these renewable energy resources for sustainable development.

The study reviewed and the present study both deals with renewable energy source. The study reviewed differs from the present study in terms of scope, geographical area and population. The previous study focused on Renewable Energy as a Solution to Nigerian Energy Crisis while the present study investigates consumers' utilisation of solar energy technologies for electricity generation in Kogi State. The present study specifically addressed the awareness and attitude of electricity consumers on solar energy technologies in Kogi State while the reviewed study addressed different renewable resources.

Britt and Wiedeman (2012) investigated semiconductor's material used in a PV cell and its importance in determining the efficiency of the solar cell at various parameters as regards to behaviour with respect to temperature, weight and as well as other parameters with which it is used and all those that contribute to the deciding factor of efficiency of the PV cell. The study used an experimental research design and data was collected based on experiment conducted. The inventor has conducted many experimental researches to devise improvised methods and apparatus for forming thin film layers of semiconductor materials. The field of photovoltaic generally relates to multi-layer materials, converts sun light directly into DC Electrical Power. The researcher found that the basic mechanism for this conversion is "The Photovoltaic Effect". Solar cells are typically configured as a co-operating sandwich of P-Type and N-Type semiconductors, in which the N-Type semi-conductor material (on one side of the sandwich) exhibits an excess of electrons and the P-Type semiconductor material (on the other side of the sandwich) exhibits an excess of holes each of which signifies the absence of the an electron. The study reviewed was related to the present study in the area of solar energy fundamentals. The study differs from the present study in terms research design and the scope of the study. The present study investigates consumers' utilisation of solar energy technologies for electricity generation in Kogi State while the reviewed study focused on solar energy basics and fundamentals.

Oji *et al*. (2012b) conducted a study on the Utilisation of Solar Energy for Power Generation in Nigeria. The study presents the viabilities for power generation in Nigeria through the utilisation of the sun's energy. The study used a survey research design and the population of the study was 200 respondents. Due to manageable size of the population, there was no sampling. Four research questions were raised and four hypotheses tested. Data collected was computed using Mean and standard deviation and t-test was used to test hypotheses at 0.05 level of significance. The study recommended that the government should subsidize the cost of importation of Renewable Energy Technologies (RET) most especially solar PV to bring down the high cost in Nigeria.

The study reviewed is related to the present study because both studies discussed solar energy as alternative method of electricity generation. The reviewed study used survey research design while the present study employed a mixed method design. Also the study differs from the present study in terms of geographical area and population.

Mutungwa (2014) conducted a study on an analysis of PV solar electrification on rural livelihood transformation: A case of Kisiju-Pwani in Mkuranga district, Tanzania. The study focused on the challenges that hinder the wide acceptability of the solar energy source by domestic consumers. Oral interview was conducted for 147 respondents across various levels of education, age and income as a way of data collection. With the use of frequency analysis, major challenges highlighted were summarized as affordability, lack of access, little or no public awareness. The study recommended probable solutions aimed at overcoming these challenges for wider acceptability. The study tried to analyse the contribution of Rural Photovoltaic solar energy electrification in the livelihood transformation process in the rural areas, based on Kisiju-Pwani village in Mkuranga District, Tanzania. The study revealed that PV solar electricity has proven to be a reliable source of energy in the rural areas which are far from the national or main grid. It is a perfect way of promoting development activities and creating opportunities for the rural area dwellers. The people's livelihood have been transformed in terms of lighting their homesteads, creating opportunities such as employment for them and enabling them to live the way they would like to live instead of relying in limited options. The reviewed study was related to the present study in terms of scope attitude towards solar energy utilisation. Data was collected and analysed using same method. The study differed from the present study in terms of geographical area and population. Also the study used a survey research design while the present study employed mixed method design. The study was carried out in Tanzania while the present study was conducted in Kogi State, Nigeria. The study reviewed addresses analysis of PV solar electrification on rural livelihood transformation while the present study investigates consumers' utilisation of solar energy technologies for electricity generation in Kogi State.

Ikponmwosa *et al*. (2014**)** carried out a study titled solar energy potential and its development for sustainable energy generation in Nigeria. The study discussed the solar energy potential for sustainable energy generation in Nigeria, the numerous issues involved in harnessing solar energy and clearly articulated a road map to enable Nigeria tap into this huge potential. The Research indicated that, Nigeria lying in the tropics, receives abundant sunshine where about 1500PJ (about 258 million barrels of oil equivalent) could be available to Nigeria annually from solar energy if solar appliances with 5% conversion efficiency were used over only one per cent of the total land area of the country for about six months of a year. Due to the numerous disadvantages of conventional fuel sources when compared with solar energy and the recent giant strides in improving solar cell efficiency using a photovoltaic (PV) device that converts 40.8% of light that hits it into electricity, Nigeria needs to reposition herself by investing in this invaluable resource to secure the energy future of our economy.

The paper showed a road map that Nigeria and by extension any developing country can follow to achieve this feat. The study used a descriptive survey research design. The population of the study was 160 Nigerians. Due to manageable size of the population, there was no sampling. Four research questions were raised and four hypotheses tested. Data collected was computed using SPSS version 20. Mean and standard deviation were used to answer research question while t-test was used to test hypotheses at 0.05 level of significance. The study reviewed was related to the present study as both focuses on solar energy utilisation for sustainable growth. The study differs from the present study in terms of geographical area and population. The reviewed study used survey research design while the present study employed mixed method design. The reviewed study focuses on a detailed road map of how the potential of solar energy can be harnessed for sustainable energy generation in Nigeria while the present study investigated consumers' utilisation of solar energy technologies for electricity generation in Kogi State.

Roman and Alan (2016) conducted a detailed study on the potential of renewable electricity sources for mining operations in South Africa. The authors investigated the potential of renewable electricity sources for mining operations in South Africa. Three research questions guided the study. Oral interview was conducted for 147 respondents across various levels of education, age and income as a way of data collection. With the use of frequency analysis. The finding of the reveled affordability, lack of access, little or no public awareness as the major challenges that affect the potential of renewable electricity sources for mining operations in South Africa . The study then recommended probable solutions aimed at overcoming these challenges for wider acceptability. The investigation of electricity usage patterns reveals that mining operations commonly have a relatively constant day and night consumption. One of the prerequisites for a suitable source is its ability to supply electricity constantly.

Most renewable sources can therefore only be used in hybrid versions, owing to relatively high intermittencies, especially with electricity supply from solar photovoltaic and wind generation. It argued that the most attractive renewable electricity sources for the corporations are, in descending order of suitability, solar PV, on-shore wind, and geothermal technology. Owing to the electricity usage patterns of mining operations and the intermittency of, especially, solar PV and wind, a hybrid version with current sources must be used. To execute a project, the business model of self-generation was identified as the most promising, and can be realized through own investment or an IPP agreement. The study adopted a purposive research design approach. This approach assisted in identifying all key factors and their potential effect on the realization of renewable electricity projects by mining corporations in South Africa. The study reviewed is related to the present study because both of the study focuses on renewable energy. The study differs from the present study in terms of area of study. The reviewed study used conceptual literature review method while the present study employed mixed method design. The study was carried out in South Africa while the present study is carried out in Kogi State, Nigeria.

Adeleke and Akinbode (2016) conducted a study titled; sustainability of solar mini-grids in Nigeria. The purpose of the study was to identify the factors responsible for the failure of mini-grids in Nigeria. The study assessed the sustainability of solar mini-grids from five perspectives of sustainability, namely; technical, economic, social, institutional and environmental using indicators. Facility assessment, focus group discussions and interviews with key informants were the methodologies employed for data collection in the two case studies selected from the northern and southern Nigeria. Findings from the study reveal that the sustainability of solar mini-grid projects is multidimensional. A project could fail due to a failure in one or a combination of the multidimensional factors.

The study showed that the sustainability of a solar mini-grid project does not only depend on its technical viability but also on its sustainability based on the economic, social, institutional and environmental dimensions of the project. Three research questions guided the study. Interview was conducted for 120 respondents across various levels for data collection. With the use of frequency analysis, major challenges highlighted were summarized as affordability, lack of access, little or no public awareness. The study then recommended probable solutions aimed at overcoming these challenges for wider acceptability. The study finds that the sustainability of a project does not only depend on its technical viability but also on its sustainability based on the economic, social, organisational and environmental perspectives. This debunks the assumption of energy users and non-energy professionals that the failure of the energy projects is due to technical failure resulting from the deployment of poor quality of products. While this study affirms project failure results from technical unviability, it also revealed that technical viability is only one of the myriad of factors that could be responsible for the failure of solar PV mini grid projects. The study reviewed is related to the present study in terms of scope (solar energy). The study differs from the present study in terms of geographical area and population. Facility assessment, focus group discussions and interviews with key informants were the methodologies employed for data collection while the present study used a mixed method. Also, the study involves the assessment of the sustainability of solar mini-grids in Nigeria while the present study investigates consumers' utilisation of solar energy technologies for electricity generation in Kogi State.

Saka *et al.* (2017) carried out a study titled; Solar Photovoltaic System: A Case Study of Akure, Nigeria. The purpose of the study was to assess the level of awareness, adoption and barriers as related to solar PV system in Akure. Four research questions were raised and four hypotheses were tested at 0.05 level of significance. A random survey was carried out on one hundred and fifty (150) residential buildings in Akure, Ondo State, Nigeria. A structured questionnaire was used to collect data from respondents. It was validated by five experts. A trial test using the test re-test method established the coefficient of stability of the instrument at 0.94 using Pearson Product Moment Correlation Coefficient. Mean and standard deviations were used to answer the research questions. The analysis of variance was used to test the hypotheses at 0.05 level of significance. Findings from the study revealed that; a large percentage of the residential buildings made use of diesel/petrol generating set as an alternative to the National grid, that the level of awareness of solar PV is significantly low, the willingness to adopt was high but it was hindered by cost implication of the system.

The findings of the study contribute to the growing literature in the adoption of renewable energy for electricity generation. It also provided a prospective market for those interested in the solar energy market. The study reviewed is related to the present study as the both studies relates to solar PV system but they differed from each other in the location of geographical area, research design and population. Also the study focused on Solar Photovoltaic System utilisation on residential buildings only while the present study investigated consumers' utilisation of solar energy technologies for electricity generation in Kogi State.

Sampaio *et al*. (2017) conducted a research on the state of art of photovoltaic solar energy through a systematic literature research, in which the following themes were approached: ways of obtaining the energy, its advantages and disadvantages, applications, current market, costs and technologies according to what has been approached in the scientific researches published until 2016. The researcher used a qualitative and quantitative approach with a non-probabilistic sample size, obtaining 142 articles published since 1996–2016 with a slitting cut.

The analysis result of the research showed that studies about photovoltaic energy are rising and may perform an important role in reaching a high-energy demand around the world. To increase the participation of photovoltaic energy in the renewable energy market requires, first, to raise awareness regarding its benefits; to increase the research and development of new technologies; to implement public policies a programmes that will encourage photovoltaic energy generation. Although crystal silicon solar cells were predominant, other types of cells have been developed, which can compete, both in terms of cost of reduction in production, or in terms of greater efficiency. The studies found out that photovoltaic solar energy are all technical. Thus creating the need for future research related to the economic viability, chain supply coordination, analysis of barriers and incentives to photovoltaic solar energy and deeper studies about the factors that influence the position of such technologies in the market. The study reviewed was related to the present study in terms of it central theme –solar energy. The study differs from the present study in terms of geographical area and population. The reviewed study used survey research design while the present study employed mixed method design. The study reviewed focused on understanding the state of art of photovoltaic solar energy while the present study investigated consumers' utilisation of solar energy technologies for electricity generation in Kogi State. Also, the study used focus group, interviews and personal contact with engineers as method of data collection while the present study will adopt the use of questionnaire.

Abdullahi *et al*. (2022) conducted a study on solar energy development and implementation in Nigeria: Drivers and Barrier. The theoretical framework was based on critical literature reviews. The research discussesed the motivational drivers to the solar energy development and the barriers hindering the implementation. The key drivers were climate change, energy demand, power sector reform Act, energy security, supply versus demand conflicts, job opportunities, technology growth and market potentials. On the other hand, the key barriers are technical, social, economic, institutional and political. Recommendations of measures to surmount the barriers to facilitate implementation are also proffered. The method used for this inquiry was based on desk study, otherwise recognised as literature-based from peered-reviews. Rather, many of secondary based were searched from published resources 2003 through 2017, with key articles obtained from PsyCho Info, ERIC, ProQuest, Science Direct, SocSci Search, EBSCO and COPAC, which are systematically narrowed to a search of any information related to the driving factors responsible for solar energy initiatives and the barriers which served as an obstacle for the implementation.

The finding from the study revealed that Nigeria has huge potentials for solar energy almost throughout the year especially the North-East zone of the country. In accordance with literature findings, the factors driving the solar energy technology include a demand for a sustainable environment to achieve the SDGs, increase in energy demand due to increase in population, Power sector reforms Act, which suggested energy mix, challenges of energy security and access, job creation, financing and market potential, the establishment of energy research centres and stakeholders in the public private partnership deals. Even though, the drivers failed the potential for solar energy initiatives in Nigeria, the industry is encircled by barriers which make the implementation difficult and almost impossible. Lack of skill personnel, consumer awareness about the product, lack of access to financing, lack of institutional framework, lack of long term policies for sustainable energy and trade barriers are hindering the deployment of solar energy initiatives in Nigeria.

The study reviewed is related to the present study in terms of barriers to proper utilisation of solar energy. The study differs from the present study in terms of geographical area and population. The reviewed study focuses solar energy development and implementation in Nigeria while the present study investigated consumers' utilisation of solar energy technologies for electricity generation in Kogi State.

2.4 Summary of Literature Review

Literature were reviewed under the following sub-headings; theoretical framework, conceptual framework and empirical studies. Relevant theories related to this study were reviewed under theoretical framework such as Ecological Modernization Theory (EMT) and Theory of Planned Behaviour (TPB). Ecological Modernization Theory (EMT) and Theory of Planned Behaviour (TPB) were used for this study because of their relationship with the adoption of renewable energy –solar power. The EMT offers theoretical conceptualization of the relationship between industrialization and environmental protectionwhile TPB speculates that if individuals consider solar energy behaviour for both domestic use and operation of MSEs significant and valuable, they will hold positive attitude to ensure that solar energy technologies are used for electricity generation.

Under conceptual framework, the concept of solar energy and Nigeria, converting solar energy to power, solar energy projects in Nigeria, perception and awareness of the public towards solar energy utilisation, consumer's attitude toward the utilisation of solar energy technologies for electricity generation and utilisation, advantages of solar energy utilisation, Strategies for effective utilisation of solar energy were discussed and under the empirical studies, closely related studies were also reviewed.

The finding from the study reviewed, showed that Nigeria has huge potentials for solar energy almost throughout the year in the country. In accordance with literature findings, the factors driving the solar energy technology include a demand for a sustainable environment, increase in energy demand due to increase in population, Power sector reforms Act, which suggested energy mix, challenges of energy security and access, job creation, financing and market potential, the establishment of energy research centres and stakeholders in the public private partnership deals. Even though, the drivers failed the potential for solar energy initiatives in Nigeria, the industry is encircled by barriers which make the implementation difficult and almost impossible. Lack of skill personnel, consumer awareness about the product, lack of access to financing, lack of institutional framework, lack of long term policies for sustainable energy and trade barriers are hindering the deployment of solar energy initiatives in Nigeria especially Kogi State. Despite the fact that the geographical location of the study area clearly indicate huge potential to generate significant amount of electrical energy from solar energy, the government, corporate bodies and individual are not seen to taking pragmatic steps towards developing and implementing policies and plans that will serve as a base line on which solar energy utilisation in the area can thrive. It is on these bases of facts that Kogi State is of interest to the researcher.

The review shows that for solar energy to be effectively utilised, the prospective consumer must be aware of it huge potentials. Therefore this work is based on the ideas that are relevant to the awareness and attitudes of electricity consumers on the utilisation of solar energy technologies for electricity generation. A lot of related empirical studies were reviewed in order to guide the researcher in selecting appropriate methodology for this study. Despite the fact that there are some similarities between the reviewed studies and the present study, all reviewed studies did not cover the geographical areas which the present study tends to address. Therefore, the present study is designed to assess the level of awareness and attitudes of consumers on the utilisation of solar energy technologies for electricity generation in Kogi State of Nigeria. The consequence of this study is that if the potentials of solar energy are known to prospective consumers in the study area it will result into effective utilisation of the technologies which will translate to stable power supply in the area giving rise to Micro and Small enterprise in the area. However, if the potentials of solar energy technologies are unknown to prospective consumers in the study area it will result to ineffective utilisation of the technologies which will translate into epileptic power supply which is currently experienced in the area. This study is therefore crucial as it is intended raise awareness which will bring about a positive attitude to prospective consumers of electricity in the study area.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Research Design

This study employed the mixed method design which is the combination of qualitative and quantitative approach to collect and analyze data. According to Teddlie and Tashakkori (2017), there are four types of mixed method research designs: (1) triangulation, (2) embedded, (3) explanatory and (4) exploratory. This study employed the sequential explanatory design, which contains first quantitative data collection through the use of questionaires followed by qualitative data collection through oral interview. This method was used in order to obtain a clearer picture from the quantitative data, and then to use the qualitative data to provide better understanding and explanation of the study in question. Schumacher *et al.* (2021) stated that the explanatory design (also called sequential design) is a two-stage mixed method design.

This design first begins with the collection and analysis of quantitative data and followed by the collection and analysis of qualitative data. In the explanatory design, the researcher recognizes particular quantitative findings that need further explanation. In order to be able to explore in depth the quantitative data, the researcher then gathered qualitative data from participants who could assist explain these results. In the current study, the main focus is on the quantitative aspects. The explanatory design is recognized as the most easy and straightforward of the mixed method designs (Schumacher *et al.*, 2021). This design is considered appropriate for this study because the two-stage structure makes it easy for the researcher to applies the two methods in separate stage and gathers only one type of data at a time and the final report can be explained in two stages, making it easy for the reader to get a clear picture from the findings.

3.2 Area of the Study

The study was carried out in Kogi State, Nigeria. Kogi State has a total land area of 27,747Km^2 (FRN, 2020) . Kogi lies approximately along latitude 7^{0}N and 6^{0}E and is bordered by Nassarawa State to the Northeast; Benue to the East; Enugu, Anambra, and Delta to the South; Edo, Ekiti and Kwara to the West; and Niger, FCT Abuja to the North (Idris, 2005).

The researcher found this area interesting for the study because from available literature, the area receives abundant sunshine all the year round being just above the equator. The sunshine duration averages 6.5 hours daily with an average flux of 5.55 kWh per square meter per day. This implies that Kogi State receives 4.851x 1012 kWh of energy per day from the sun. The solar radiation intensities range from 3.5-7.0 kWh per square meter per day increasing from the South to the North (Oseni, 2012). This energy source could be available for 26% of the day (9.00am-4.00pm). These facts and figures regarding geographical location of Kogi State clearly indicate that the potential to generate significant amount of electrical energy from solar energy is very high.

3.3 Population of the Study

The targeted population for the study was 216,736 comprising of 136,105 household heads, 80,431 Micro and Small Enterprises (MSEs) and 200 licensed electricians from the three (3) zones in Kogi state. The population distribution from each zone is presented in table 3.1 below.

Table 3.1 Population Distribution for the Study Area

S/No	Zone (Town)	Household Heads	MSEs Operators	Electricians
1	East (Anyigba)	45,369	26710	67
2	West (Lokoja)	45,373	27111	66
3	Centre (Okene)	45,363	26610	67
Total		**136,105**	**80,431**	**200**

Source: Abuja Electricity Distribution Company (AEDC), Small and Medium Enterprise Development Agency of Nigeria (SMEDAN) National Bureau of Statistics (NBS) and License Electrical Contractors Association of Nigeria (LECAN).

3.4 Sample and Sampling Techniques

A multistage sampling technique was used for the study. Firstly, a cluster sampling technique was used to cluster kogi state into three (3) geo-political zones namely; Kogi East with the major town in Anyigba, Kogi west with the major town in Lokoja and Kogi centre with the major town in Okene. Secondly, a simple random sampling technique was used to draw 132, 133, 129 respondents from Anyigba, Lokoja and Okene respectively which gave a total of 394 respondents to the questionnaire. Finally purposive sampling technique was used to sample 20 respondents from the three geopolitical zones for the interview.

Table 3.2 shows the sample distribution for the study.

Table 3.2: Sample Distribution for the Study

S/N	Zone (Town)	Household Heads	MSEs Operators	Electricians
1	East (Anyigba)	74	36	22
2	West (Lokoja)	75	36	22
3	Centre (Okene)	73	36	20
Total		**222**	**108**	**64**

3.5 Instrument for Data Collection

The instrument for data collection was a structured questionnaire and oral interview. In the qualitative approach which aims at answering questions from the respondents, interviews was conducted while in the quantitative approach, a structured questionnaire titled: Awareness and Attitudes of Electricity Consumers on Solar Energy Technologies for Electricity Generation and Utilisation Questionnaire (AAECSETEGUQ) was used for data collection on the various research questions raised. The use of structured questionnaire is cheaper and relatively fast to receive responses and also gives room for large sample to be spread over a wide area to be surveyed (Uzoagulu, 2011).

The questionnaire which comprised of 82 items was developed by the researcher after review of relevant literature and experts' opinion in notable solar energy consult for data collection. The questionnaire was divided into two parts (I and II) Part I contains items designed to obtain personal information of the respondents. The items have options and blank spaces to enable the respondents tick or complete as appropriate. Part II was divided into six clusters (A, B, C, D, and E). cluster A contains 15 items designed to identify the level of awareness of consumers on solar energy technologies for electricity generation and utilisation; cluster B consists of 14 items that deal with investigating the attitudes of electricity consumers on the utilisation of solar energy technologies for electricity generation and utilisation; cluster C is made up of 15 items designed to find out the perception of electricity consumers on the utilisation of solar energy technologies for electricity generation; cluster D has 15 items designed to identify factors affecting the effective utilisation of solar energy technologies for electricity generation and cluster E has 10 items designed identify some strategies for the effective utilisation of solar energy technologies for electricity generation.

The questionnaire items were assigned a four-point response scale option of Strongly Agreed (SA)/Highly Aware (HA), Agree (A)/Aware (A), Disagree (D)/ Not Aware (NA) and Strongly Disagree (SD)/ Highly Not Aware (HNA) with a weighing value of 4, 3, 2 and 1 respectively.

3.6 Validation of the Instrument

A draft copy of the research instrument "(AAECSETEGUQ)" and the items for oral interview were face validated by three experts from Electrical/Electronic option of the department of Industrial and Technology Education, Federal University of Technology, Minna. According to Mosier (2013), face validity ensures that the questionnaire appears valid for its intended purpose (see appendix A on page 100). The validates were given copies of the questionnaire each and requested to correct ambiguous or unclear statements with reference to the items in the questionnaire and make relevant corrections/suggestions for improving the instrument towards meeting the objectives of the study. Their criticism and suggestions were noted and corrections effected accordingly (see Appendix C on page 109). The questionnaire is attached as Appendix B on page 101.

3.7 Reliability of the Instrument

To establish the reliability of the instrument, a preliminary study was conducted on 15 household heads, 10 MSEs operators and 5 electricians totaling 30 respondents in Niger state which is outside the study area but have similar features to the studied area. This is in line with the opinion of Uzoagulu (2011) that the reliability of an instrument is the consistency of the instrument in measuring whatever it purports to measure. The data generated were analysed using Cronbach Alpha Reliability Coefficient. The reliability coefficient obtained for the various clusters of the instrument were as follows: A= 0.79, B= 0.71; C= 0.72; D= 0.82; E= 0.73. The whole questionnaire has a reliability of 0.77 indicating that the instrument is considered reliable. The computer output on the computation for this reliability estimate is attached as Appendix D on page 110.

3.8 Method of Data Collection

The researcher administer the instruments to the respondents with the help of 3 research assistants, that is one each from the three towns drawn for the study. The research assistants were trained on how to use the questionnaires after which they were asked to distribute and retrieve the questionnaire. The research assistants were required to give the respondents one to two days before collecting the questionnaires, while the researcher retrieved them from the research assistants. Out of the 364 questionnaires distributed, 308 were duly returned and analysed. This number represent 85% response rate which is in line with the assertion of Yousuf (2020) who said that a response rate of 50% or more in a survey is considered excellent.

3.9 Method of Data Analysis

The quantitative data which involve the use of questionnaire was analysed using mean and standard deviation. The weights assigned as indicated against the scale was used to compute the means and standard deviation scores of each item of the questionnaire and that of each of the clusters. Real limits of numbers and criterion mean was be used to answer the research questions while analysis of variance (ANOVA) was used to test the hypotheses. The decision on each item was based on the following real limits of numbers: 0.50-1.49 = Strongly Disagree (SD)/ Highly Not Aware (HNA) 1.50-2.49 = Disagree (D)/ Not Aware (NA), 2.50-3.49 = Agree (A)/Aware (A), 3.50-4.00= Strongly Agreed (SA)/Highly Aware (HA). ANOVA was used to test the significant difference between the mean scores of the respondents. Where the *p*-value was found to be less than .05, then the null hypotheses was rejected but where *p*-value was found to be more than .05, the null hypotheses was accepted.

In the qualitative data which entails oral interview, the researcher interviewed the respondents and had their responses recorded. The recorded interviews were listened to and the audio transcribed. After the transcription, the researcher then carried out a thematic analysis by looking for reoccurring words and idea in the transcription and then incorporated them in the findings and recommendations of the study. All statistical calculations were done using the Statistical Package for the Social Sciences (SPSS) version 23 to enhance speed and accuracy of the analysis.

Standard deviation was used to decide on the closeness or otherwise of the respondents to the mean in their responses. Any item with a standard deviation less than 1.96 indicated that the respondent were not too far from the mean or from one another in their responses and any item equal or above 1.96 indicated that the respondents are too far from the mean. Decisions on the hypotheses were based on comparing the significant value with ($P < .05$) level of significance. Where the significance value was equal or greater than ($P < .05$) level of significance, the hypothesis was upheld, while when the value was less than ($P < .05$) the hypothesis was rejected. Levenes' test of homogeneity of variances was carried out to test the similarities; in view of the fact that one of the assumptions of One-way ANOVA is that the variances of the groups must be similar. If the significant value is greater than 0.05 then there is homogeneity of variances and the assumptions of homogeneity of variances is met. However, if the Lvenes' F statistics is significant and less than 0.05 then there were no similar variances and it will be necessary to refer to the test of equality of means table instead of the ANOVA Table. Tukey Honest Significant Difference (HSD) test for multiple comparisons were used where significant mean differences exist in other to locate the group responsible for the rejection of the null hypothesis. The Tukey HSD Post-hoc test is the generally accepted way of carrying out post-hoc test on one-way ANOVA. The Tukey HSD uses a wider interval to compare all pair of differences in a table, $P < 0.05$ levels, to ensure that there is no risk greater than 5% in any of the comparisons are significant when they are not.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

The data collected for the study were analysed and presented in this chapter. The analysis and presentation were organized based on research questions and hypotheses of the study.

4.1 Research Question 1

What is the level of awareness of consumers on solar energy technologies for electricity generation and utilisation?

The data for answering research question one were presented in Table 4.1

Table 4.1: Mean and Standard Deviation of Respondents on the level of awareness of consumers on solar energy technologies for electricity generation and utilisation **N = 308**

S/N	Description/Item Statement	$\bar{x}$	SD	Remark
1	Solar technologies operation is noiseless	3.22	0.86	A
2	Solar technologies has infinite energy source	3.11	0.94	A
3	Solar technologies has a very high life span	3.22	0.97	A
4	Solar technologies are environmentally friendly in nature with respect to release of greenhouse gases, global warming, ozone layer depletion	3.29	0.63	A
5	Solar energy technologies is convenient, safe and has no monthly bills after initial investment	3.60	0.48	HA
6	Solar energy technologies could help address energy access for MSEs and domestic use	3.59	0.49	HA
7	Concentrating solar power plants provide the lowest cost power of any solar technology	3.20	0.87	A
8	Photovoltaic (PV) panels are available in different sizes or modules over a wide range of power rating	3.19	0.59	A
9	Concentrated Solar Power will decrease global warming	3.40	0.66	A
10	Investment in solar technologies for electricity generation saves money since there are no monthly bills after initial investment	3.29	0.63	A
11	Generating electrical energy through PV and CSP systems have low operational and maintenance cost	2.87	0.82	A
12	Solar energy technologies produces no smoke like gasoline generators when generating electricity	3.29	0.77	A
13	Solar power plants can last more than 35 years	3.01	0.78	A

14	Solar panels actually work more efficiently in colder temperatures because excessive heat can reduce output voltage	3.19	0.59	A
15	The solar panels generally increases home values	3.60	0.48	HA
16	Concentrating solar power system has Shorter energy-payback period	3.19	0.97	A
17	Solar energy technology can be embraced by people across an entire sociopolitical spectrum	3.50	0.50	HA
18	Solar panels are generally sleek, compact and fit neatly against the roof	3.39	0.66	A
19	Power generated through solar energy technologies can be used for pumping of water and operates electronics appliances	3.41	0.66	A
20	Solar energy technologies allow you to enjoy 24 hours power supply with the aid of battery	3.09	0.82	A
21	With the use of solar technologies, I can power my home when the power from the grid system goes out	3.07	0.83	A
22	Concentrated Solar Power creates recyclable energy	2.79	1.07	A
	Grand Mean	**3.25**	**0.68**	**A**

Key: N = Number of respondents; $\bar{x}$ = mean; SD = Standard Deviation; A = Agree; R= remark

Data in Table 4.1 showed means and standard deviations on the level of awareness of consumers on solar energy technologies for electricity generation and utilisation. The respondents' mean items 5,6,15,17 had their mean values within the real limit of 2.50 – 3.49, indicating that electricity consumers are highly aware of the four awareness items on solar energy technologies for electricity generation and utilisation. Similarly, the data further revealed that the respondents' mean items 1,2,3,4,7,8,9,10,11,12,13, 14,16,18,19,20,21,22 had their mean values within the real limit of 2.50 – 3.49, indicating that the consumers are aware of the eighteen awareness items on solar energy technologies for electricity generation and utilisation. The grand mean of the total respondents stood at 3.25, which indicate that the consumers are awareness of solar energy technologies for electricity generation and utilisation. All the 22 standard deviation on each items were within the real limit of 1.96 indicating that the respondents were not too far from the mean response of one another in their responses.

The result from the interview which is meant to support the questionnaire revealed that 18 out of 20 respondents that were interviewed on level of awareness of consumers on solar energy technologies for electricity generation and utilisation revealed that they were aware of solar energy technologies. When asked why solar energy is considered as the right energy source to address energy access for MSEs and domesticity, an MSEs operator said: "of course it is, because it is environmentally friendly in nature and have low cost of maintenance". An Electrician was asked if he has knowledge on the different sizes or modules of Photovoltaic (PV) panels available to consumers for electricity generation with respect to their power rating, he responded thus: "Photovoltaic (PV) panels are available in different ratings, we have 100W, 150W and 180W which gives the maximum of 17.5V. Also, we have the one of 200W, 250W, 280W, 300W, 350W and 380W rated in 24V system. Most of them have a VOC of 36.5-40 depending on the manufacturers and the size". A residents who was asked about what he knows on concentrated solar power system said: CSP uses mirror to concentrate heat on an arrangement that generate steam to turn a turbine in order to generate electricity. Overall, about 90% of the respondent showed that they were aware of solar energy technologies.

4.2 Research Question 2

What are the attitude of consumers on the utilisation of solar energy technologies for electricity generation?

The data for answering research question two were presented in Table 4.2

Table 4.2: Mean and Standard Deviation of Respondents on the attitudes of consumers on the utilisation of solar energy technologies for electricity generation N=308

S/N	Description/Item Statement	$\bar{x}$	SD	R
1	Adoption of Solar energy technologies for electricity generation is important to me because solar power causes less electricity loss due to absence of long distance transmissions of electric current	3.02	0.78	A
2	Difficulty in installation and lack of technical know-how is the major factor for my non-adoption of solar energy technologies	3.19	0.74	A
3	Durability of solar energy technologies impacts my willingness to adopt solar energy technologies for the generation and utilisation of electricity	3.17	0.61	A
4	Favorable comments from friends and neighbors have significant positive impacts on my willingness to adopt solar energy technologies for the generation and utilisation of electricity	3.20	0.74	A
5	I am not interested in adopting solar technologies because too much maintenance is required	3.31	0.99	A
6	I am willing to adopt solar energy technologies because of my strong desire for economic independence	3.00	0.76	A
7	I am willing to take low-cost loans to invest in solar power for the generation and utilisation of electricity	3.37	0.68	A
8	I will not adopt solar energy technologies for electricity generation and utilisation I have low information about the new technology	2.89	0.69	A
9	I will only adopt solar energy technologies if I receive financial incentives or supports from governments or non-governmental organization	3.11	0.94	A
10	I will rather adopt solar energy technologies because the technology is safe and environmentally-friendly compared to fossil fuel generator	3.00	0.88	A
11	My knowledge and belief about costs of renewable energy such as solar energy use is the major factor consider before adopting solar energy technologies	3.41	0.66	A
12	My knowledge of environmental issues is the reason for the willingness to pay for green technologies such as solar power	3.00	0.88	A
13	I am willing to use solar energy technologies to generate and utilize electricity because of poor electricity supply	3.11	1.13	A
14	Solar energy technologies is important to me because it gives me alternative to grid electricity supply	2.90	0.82	A
	Grand Mean	**3.12**	**0.81**	**A**

Key: N = Number of respondents; $\bar{x}$ = mean; SD = Standard Deviation; A = Agree; R= remark

Data in Table 4.2 showed means and standard deviations on the attitude of consumers towards solar energy technologies for electricity generation and utilisation. The data revealed all the items had their mean values within the real limit of 2.50 – 3.49, indicating that all the items on attitude of consumers on the utilisation of solar energy technologies for electricity generation were agreed. All the 14 standard deviation on each items were within the real limit of 1.96 indicating that the respondents were not too far from the mean or from one another in their responses.

The result from the interview which aimed to support the questionnaire revealed that 19 out of 20 respondents that were interviewed on attitudes of consumers on the utilisation of solar energy technologies for electricity generation revealed that consumers have good attitude towards solar energy technologies. When asked how attitude of electricity consumers affect the adoption and utilisation of solar energy technologies for electricity generation, an MSEs operator said “Knowledge of environmental issues is the major reason why people adopt solar technologies”. Another respondent -a technician said “strong desire for economic independence reason why people adopt solar technologies”. In the same vein, a resident said knowledge of environmental issues is reason why people adopt solar technologies. Overall, about 95% of the respondent showed that attitude of electricity consumers affect the adoption and utilisation of solar energy technologies.

4.3 Research Question 3

What are the perceptions of consumers on the utilisation of solar energy technologies for electricity generation?

The data for answering research question three were presented in Table 4.3

Table 4.3: Mean and Standard Deviation of Respondents on the perceptions of consumers on the utilisation of solar energy technologies for electricity generation. **N = 308**

S/N	Description/Item Statement	$\bar{x}$	SD	Remark
1	Solar technologies has poor aesthetics	3.18	1.07	A
2	Solar technologies is expensive to purchase	3.39	0.65	A
3	There is lack of government grants for solar technologies investment	3.60	0.48	SA
4	Solar technologies require too much maintenance	3.09	0.69	A
5	Solar technologies does not add value to property	3.07	0.71	A
6	Solar technologies is difficult to install	2.99	0.88	A
7	Solar technologies is not yet mature hence it is only suited for particular markets and will require heavy subsidy to make it viable	3.11	0.70	A
8	Solar technologies has High propensity for theft	2.89	0.69	A
9	Solar technologies is not viable for industrial purposes	2.73	0.91	A
10	You can't install a solar Photovoltaic panels yourself	2.80	0.97	A
11	Not all solar panels are of high quality	2.57	1.10	A
12	Solar Photovoltaic panels and concentrated solar power required large expanse of land for their installation	2.80	0.59	A
13	Photovoltaic panels in Nigeria market are characterized with low efficiencies	3.11	0.94	A
14	There is lack of capacity and inadequate expertise to develop, and manage the solar energy technologies	3.09	0.69	A
15	There are no established standard and quality control systems of both locally and imported manufactured technologies	3.50	0.75	SA
16	Solar energy technologies cannot meet energy demands	3.19	0.59	A
17	Solar panels and CSP system do not work in cold weather or when it is cloudy	3.18	0.66	A
18	Solar energy is too costly and is not economically viable	2.90	0.53	A
19	Installing solar is quite complicated	3.37	0.68	A
20	Solar panels will cause damage to your roof	3.00	0.44	A
21	Reselling your home/facility will be harder with solar panels	3.21	0.74	A
22	Solar panel prices are based on the size of your home	3.00	0.63	A
23	Solar panels are bad for the environment after their lifetime is used up	3.27	0.65	A
24	Solar panels are toxic and can’t be recycled	3.19	0.59	A
	Grand Mean	**3.09**	**0.72**	**A**

Note: N = Number of respondents, $\bar{x}$ = mean; SD = Standard Deviation; SA = Strongly Agree; A = Agree.

Data in Table 4.3 showed means and standard deviations on the perceptions of consumers towards solar energy technologies for electricity generation and utilisation. The respondents’ mean items 3 and 15 had their mean values within the real limit of 3.50 – 4.00, indicating that the 2 items on perceptions were strongly agreed. Similarly, the data further revealed that the remaining twenty two items had their mean values within the real limit of 2.50 – 3.49, indicating that 22 items were agreed on the perceptions of consumers on the utilisation of solar energy technologies for electricity generation. All the 22 standard deviation on each items were within the real limit of 1.96 indicating that the respondents were not too far from the mean or from one another in their responses.

The result from the interview which is aimed to support the questionnaire revealed that 18 out of 20 respondents that were interviewed on perceptions of electricity consumers towards the utilisation of solar energy technologies for electricity generation have positive perception towards solar energy technologies for electricity generation and utilisation. When asked on their opinion on solar technologies aesthetics, solar technologies maintenance, solar technologies installation cost, photovoltaic panel's efficiency and standard and quality control systems of both locally and imported manufactured technologies how it affects solar energy technologies. One technician said: "the aesthetic nature of solar technologies is awesome and beautiful, easy to install". Another respondent, a resident said: "Solar technologies have high initial installation cost but has high pay-back benefits". Similarly, an MSEs operator said; "Solar technologies require no or little maintenance". In contrast to the positive opinion of solar technologies, seven respondents out of the twenty that were interviewed had different opinions. An electrician said "solar photovoltaic panels and concentrated solar power required large expanse of land for their installation". MSEs operator said: "solar energy technologies most a times don't meet energy demands and it is too costly and is not economically viable". Residents when asked said: "solar technologies require too much maintenance. Another MSEs Operator said "solar panels are bad for the environment after their lifetime is used up". Overall, about 95% of the respondent showed positive perceptions towards solar technologies for electricity generation and utilisation.

4.4 Research Question 4

What are the factors affecting the effective utilisation of solar energy technologies for electricity generation?

The data for answering research question four were presented in Table 4.4

Table 4.4: Mean and Standard Deviation of Respondents on the limiting factors affecting the effective utilisation of solar energy technologies for electricity generation **N =308**

S/N	Limiting Factors	$\bar{x}$	SD	Remark
1	Absence of establishment such as renewable energy data recording stations amongst others	3.32	0.77	A
2	High propensity to theft	3.10	0.53	A
3	Has initial high costs of purchase and installation	2.87	0.70	A
4	Solar technologies require high up frontal capital cost compared to its conventional energy alternatives	3.10	0.53	A
5	Solar technologies require large expanse of land for their installation	3.11	0.94	A
6	Some PV panels are characterized with low efficiencies	2.70	0.89	A
7	Absence of equipped laboratories/research centres for solar PV research	2.99	0.99	A
8	Lack of credit facilities to purchase solar technologies	3.19	0.86	A
9	Lack of manpower and the desired technological skills to manage solar energy technologies efficiently	3.70	0.45	SA
10	Limited application of solar energy technologies domestically and commercially	3.10	0.53	A
11	Limited or few service providers of solar energy technical services	3.22	0.74	A
12	Several counterfeit solar energy technologies goods on the market	3.29	0.64	A
13	Low level of awareness on the huge health, socio-economic and environmental benefits derivable from solar energy use	3.37	0.68	A
14	Lack of effective national energy policy	3.19	0.74	A
15	Lack of financial and fiscal incentives towards the utilisation of solar technologies	3.01	1.00	A
	Grand Mean	**3.15**	**0.73**	**A**

Note: *N = Number of respondents;* $\bar{x}$ *= mean; SD = Standard Deviation; A = Agree; SA = Strongly Agree.*

Data in Table 4.4 showed means and standard deviations on the limiting factors affecting the effective utilisation of solar energy technologies for electricity generation. The respondents' mean item 9 had its mean values within the real limit of 3.50 – 4.00, indicating that the one limiting factors affecting the effective utilisation of solar energy technologies for electricity generation was strongly agreed. Similarly, the data further revealed items 1,2,3,4,5,6,7,8,10,11,12,13,14,15 had their mean values within the real limit of 2.50 – 3.49, indicating that the forteen items were agreed as the the limiting factors affecting the effective utilisation of solar energy technologies for electricity generation. Fourteen items had their standard deviation within the real limit of 1.96 indicating that the respondents were not too far from the mean or from one another in their responses.

The result from the interview based on limiting factors affecting the utilisation of solar energy technologies for electricity generation revealed the opinion of the respondent thus; high initial setup cost, poor design of unprofessional professionals, poor power management on the side of the consumers, and lack of public awareness on the efficacy of using solar power system among others factors affecting the utilisation of solar energy technologies.

4.5 Research Question 5

What are the strategies for the effective utilisation of solar energy technologies for electricity generation?

The data for answering research question five were presented in Table 4.5

Table 4.5: Mean and Standard Deviation of Respondents on the strategies for the effective utilisation of solar energy technologies for electricity generation **N = 308**

S/N	Description/Item Statement	$\bar{x}$	SD	Remark
1	There is need to put in place an effective mechanism to check the entry of counterfeits, because they affect public confidence in the solar technologies available on the market	3.29	0.63	A
2	Information concerning the development, applications, dissemination and diffusion of solar energy resource and technologies should be stepped up through; the media, mobile networks, schools etc	3.27	0.65	A
3	Subsidized cost of importation of solar PV devices by Government	3.19	0.59	A
4	Eradication or reduction of poverty level to the Barest minimum by the Government so that people can afford to invest in solar energy technologies	3.41	0.66	A
5	Introduction of renewable energy incentives similar to the “feed-in-tariffs” by the Government to enhance increased consumption of renewable energy such as solar energy	3.10	0.69	A
6	Provision of soft loans and financial assistance by financial institutions, government and non-governmental organisations to individuals so that people can afford to invest in solar energy technologies	2.92	1.05	A
7	Sensitization programmeme through mass media to increase the level of awareness on the merit of investment of consumption of renewable energy products such as solar technologies	2.80	0.74	A
8	Establishment of Research centres on renewable energy technology and properly equipped existing ones	2.68	0.99	A
9	Placing restrictions on the importation of diesel and petrol engine generators by the government because of its adverse effects on the environment	2.60	0.91	A
10	Funding of solar technology researches and development initiatives in higher institutions so as to develop solar PVs with increased efficiency that will be adaptable to our environment	3.40	0.79	A
	Grand mean	**3.07**	**0.77**	**A**

Note: N = Number of respondents; $\bar{x}$ = mean; SD = Standard Deviation; A = Agree.

Data in Table 4.5 showed means and standard deviations on the interventional strategies for the effective utilisation of solar energy technologies for electricity generation. The respondents’ mean item revealed that all the 10 items had their mean values within the real limit of 2.50 – 3.49, indicating that all the interventional strategies for the effective utilisation of solar energy technologies for electricity generation were strongly agreed. Similarly, the ten items had their standard deviation within the real limit of 1.96 indicating that the respondents were not too far from the mean or from one another in their responses.

The suggestion during the interview conducted with electrician, residents and MSEs operators based on the strategies for the effective utilisation of solar energy technologies for electricity generation are: training and retraining of technician, quality design of the system, quality control on the standard of the solar system, and sensitization programmeme through mass media to increase the level of awareness on the merit of investment of consumption of renewable energy products such as solar technologies were among other strategies for the effective utilisation of solar energy technologies for electricity generation.

4.6 Hypothesis 1

There is no significant difference among the mean responses of electrician, residents and MSEs operators as regards the level of awareness of solar energy technologies for electricity generation and utilisation. ($P<.05$)

The result of the One-way ANOVA of mean scores of the respondents on the significant difference in mean responses of electrician, residents and MSEs operators on their level of awareness of solar energy technologies for electricity generation and utilisation in is presented in Table 4.6. Levenes test of homogeneity of variances for the data was .087 (see appendix G on page 115 for homogeneity of variances). Therefore, the assumption of homogeneity was met. Since the value is greater than the significant level of ($P<.05$), therefore, ANOVA can be used for analysis.

Table 4.6: **Summary of one way analysis of variance showing the difference among the mean responses of electrician, residents and MSEs operators as regards the level of awareness of of solar energy technologies for electricity generation and utilisation**

	Sum of Squares	Df	Mean Square	F	Sig.	Remark
Between Groups	.488	2	.244	.014	.087	NS
Within Groups	5385.574	305	17.658			
Total	5386.062	307				

(P<0.05) NS = No Significant

Table 4.6 revealed that there was no significant difference (P<0.05) in the mean ratings of the respondents. These data supported the hypothesis, *F(2, 305)* = .014, p = .087. The mean and standard deviation for resident were 3.25 and 0.19 respectively. Similarly, the mean and standard deviation for MSEs were 3.25 and 0.20. In addition, the mean and standard deviation for Electricians were 3.30 and 0.20 respectively. Hence, hypothesis one was upheld. This mean, there was no significant difference in the mean achievement scores of residents, MSEs and Electricians as regards the level of awareness of of solar energy technologies for electricity generation and utilisation.

4.7 Hypothesis 2

There is no significant difference among the mean responses of electrician, residents and MSEs operators in as regards the attitude of electricity consumers on the utilisation of solar energy technologies for electricity generation. (P<.05)

The result of the One-way ANOVA of mean responses of the respondents on the significant difference between the electrician, residents and MSEs operators on their attitude towards solar energy technologies for electricity generation and utilisation is presented in Table 4.7. Levenes test of homogeneity of variances for the data was .085 (see appendix G for homogeneity of variances). Therefore, the assumption of homogeneity was met. Since the value is greater than the significant level of (P<.05). Therefore, ANOVA can be used for analysis.

Table 4.7: Summary of one way analysis of variance showing the difference among the mean responses of electrician, residents and MSEs operators as regards the attitude of electricity consumers on the utilisation of solar energy technologies for electricity generation

	Sum of Squares	Df	Mean Square	F	Sig.	Remark
Between Groups	.827	2	.413	.021	.085	NS
Within Groups	5902.394	305	19.352			
Total	5903.221	307				

(P<0.05) NS = No Significant

Table 4.7 revealed that there was no significant difference (P<0.05) in the mean ratings of the respondents. These data supported the hypothesis, *F(2, 305)* = .021, p = .085. The mean and standard deviation for resident were 3.12 and 0.12 respectively. Similarly, the mean and standard deviation for MSEs were 3.13 and 0.32 and the mean and standard deviation for Electricians were 3.12 and 0.31 respectively (See Appendix G, Page 115). Hence, hypothesis two was upheld. This means that there was no significant difference in the mean responses of residents, MSEs and Electricians as regards the attitude of electricity consumers on the utilisation of solar energy technologies for electricity generation.

4.8 Hypothesis 3

There is no significant difference among the mean responses of electrician, residents and MSEs operators as regards the perception of electricity consumers on the utilisation of solar energy technologies for electricity generation. (P<.05)

The result of the One-way ANOVA of mean scores of the respondents on the significant difference between the electrician, residents and MSEs operators on their preceptions towards solar energy technologies for electricity generation and utilisation is presented in Table 4.8. Levenes test of homogeneity of variances for the data was .061 (see appendix G for homogeneity of variances). Therefore, the assumption of homogeneity was met. Since the value is greater than the significant level of (P<.05). Therefore, ANOVA can be used for analysis.

Table 4.8: Summary of one way analysis of variance summary table showing the difference among the mean responses of solar energy technicians, residents and MSEs operators as regards the perception of electricity consumers on the utilisation solar energy technologies for electricity generation.

	Sum of Squares	**Df**	**Mean Square**	**F**	**Sig.**	**Remark**
Between Groups	1.175	2	.588	.039	.061	NS
Within Groups	4604.136	305	15.096			
Total	4605.312	307				

(P<0.05) NS = No Significant

Table 4.8 revealed that there was no significant difference (P<0.05) in the mean ratings of the respondents. These data supported the hypothesis, $F(2, 305) = .039$, p = .061. The mean and standard deviation for resident were 3.09 and 0.16 respectively. Similarly, the mean and standard deviation for MSEs were 3.10 and 0.16 and the mean and standard deviation for Electricians were 3.10 and 0.20 respectively (See Appendix G, Page 115). Hence, hypothesis three was upheld. This mean, there was no significant difference in the mean responses of residents, MSEs and Electricians as regards the perception of electricity consumers on solar energy technologies for electricity generation and the utilisation.

4.9 Hypothesis 4

There is no significant difference among the mean responses of electrician, residents and MSEs operators as regards the factors affecting the effective utilisation of solar energy technologies for electricity generation. ($P<.05$)

The result of the One-way ANOVA of mean responses of the respondents on the significant difference in the mean rating of electrician, residents and MSEs operators on their attitude towards solar energy technologies for electricity generation and utilisation is presented in Table 4.9. Levenes test of homogeneity of variances for the data was .057 (see appendix G on page 115 for homogeneity of variances). Therefore, the assumption of homogeneity was met. Since the value is greater than the significant level of ($P<.05$), therefore, ANOVA can be used for analysis.

Table 4.9: Summary of one way analysis of variance showing the difference among the mean responses of electrician, residents and MSEs operators as regards the factors affecting the effective utilisation of solar energy technologies for electricity generation.

	Sum of Squares	Df	Mean Square	F	Sig.	Remark
Between Groups	.448	2	.224	.010	.057	NS
Within Groups	6841.432	305	22.431			
Total	6841.880	307				

($P<0.05$) NS = No Singnificant

Table 4.7 revealed that there was no significant difference ($P < 0.05$) in the mean ratings of the respondents. These data supported the hypothesis, $F(2, 305) = .010$, p = . .057. The mean and standard deviation for resident were 3.15 and 0.32 respectively. Similarly, the mean and standard deviation for MSEs were 3.16 and 0.31 and the mean and standard deviation for Electricians were 3.15 and 0.31 respectively (See Appendix

G, Page 115). Hence, hypothesis four was upheld. This mean, there was no significant difference in the mean rating of residents, MSEs and Electrians as regards the limiting factors affecting the effective utilisation of solar energy technologies for electricity generation.

4.10 Hypothesis 5

There is no significant difference in the mean responses of electrician, residents and MSEs operators as regards the strategies for effective utilisation of solar energy technologies for electricity generation.

The result of the One-way ANOVA of mean responses on the significant difference in the mean rating of electrician, residents and MSEs operators on the strategies for effective utilisation of solar energy technologies for electricity generation is presented in Table 4.10. Levenes test of homogeneity of variances for the data was .096 (see appendix G for homogeneity of variances). Therefore, the assumption of homogeneity was met. Since the value is greater than the significant level of (P<.05), therefore, ANOVA can be used for analysis.

Table 4.10: Summary of one way analysis of variance showing the difference among the mean responses of electrician, residents and MSEs operators as regards the strategies for effective utilisation of solar energy technologies for electricity generation.

	Sum of Squares	Df	Mean Square	F	Sig.	Remark
Between Groups	1.094	2	.547	.067	.096	NS
Within Groups	2483.020	305	8.141			
Total	2484.114	307				

(P<0.05) NS = No Significant

Table 4.10 revealed that there was no significant difference ($P<0.05$) in the mean ratings of the respondents. These data supported the hypothesis, $F(2, 305) = .067$, $p = .096$. The mean and standard deviation for resident were 3.06 and 0.28 respectively. Similarly, the mean and standard deviation for MSEs were 3.06 and 0.28 and the mean and standard deviation for Electricians were 3.08 and 0.28 respectively. Hence, hypothesis five was upheld. This means that, there was no significant difference in the mean responses of residents, MSEs and Electricians as regards the strategies for effective utilisation of solar energy technologies for electricity generation.

4.11 Findings of the Study

The following findings emerged from the study based on the research questions answered and the hypotheses tested.

1. The findings of the study on research question one on the level of awareness of consumers revealed that the respondents are highly aware of four items and aware of the remaining 18 items on the awareness list. The result from the interview revealed that 95% of the respondents were aware of solar energy technologies for electricity generation.
2. The findings of the study on research question two on consumers' attitude towards solar energy technologies showed that respondents agreed to all items. This means that consumers have good attitude towards solar energy technologies. The result from the interview bothering on attitude of consumers on the utilisation of solar energy technologies for electricity generation revealed that 90% of the respondent showed positive attitude to solar technologies for electricity generation.
3. The findings of the study on research question three on consumers' perception towards solar energy technologies showed that respondents strongly agreed to 2

items while the remaining 22 items were agreed. This revealed that the repondents have positive perception towards utilisation of solar energy technologies for electricity generation. The result from the interview on the perceptions of electricity consumers revealed that 95% of the respondent showed positive perceptions towards the utilisation of solar energy.

4. The findings of the study on research question four relating to factors affecting the effective utilisation of solar energy technologies showed that respondents strongly agreed to 1 item and agreed to the remaining 14 items. The interview result revealed the following as some of the limiting factors: High initial setup cost, Poor design of unprofessional professionals, Poor power management on the side of the consumers among others.
5. The findings of the study on research question five on the strategies for effective utilisation of solar energy technologies for electricity generatio showed that the respondents agreed to all the 10 items. The result from the interview had the following suggestions as the strategies: Stakeholders in the solar power industry should carryout public awareness programme so that people can be sensitized on the efficacy of using solar technologies for electricity generation and utilisation
6. The findings of the study on hypothesis one revealed that there was no significant difference in the mean ratings of the responses of electricians, residents and MSEs operators on the level of awareness of solar energy technologies for electricity generation and utilisation.
7. The findings of the study on hypothesis two revealed that there was no significant difference in the mean ratings of the responses of electricians, residents and MSEs operators on the attitude of electricity consumers on the utilisation of solar energy technologies for electricity generation.

8. The findings of the study on hypothesis three revealed that there was no significant difference in the mean ratings of the responses of electricians, residents and MSEs operators on the perception of electricity consumers on the utilisation of solar energy technologies for electricity generation.
9. The findings of the study on hypothesis four revealed that there was no significant difference in the mean ratings of the responses of electricians, residents and MSEs operators on the factors affecting the effective utilisation of solar energy technologies for electricity generation.
10. The findings of the study on hypothesis five revealed that there was no significant difference in the mean ratings of the responses of electricians, residents and MSEs operators on the strategies for effective utilisation of solar energy technologies for electricity generation.

4.12 Discussion of Findings

The major findings of the study were discussed in the order of the research questions and hypotheses formulated for study.

The finding relating to research question one revealed that the respondents are highly aware of 4 items and are also aware of the remaining 18 items which is indicative of the fact that the respondents have good level of awareness of solar energy technologies for electricity generation and utilisation. The findings of the study on awareness of consumers on solar energy technologies are in agreement with the findings of Britt and Wiedeman (2012) who said that, Solar energy technologies could help address energy access for MSEs and domestic use**,** solar panels generally increases home values and can be embraced by people across an entire sociopolitical spectrum, safe and has no monthly bills after initial investment..

Similarly, the findings of the study is also in conformity with the findings of Lawal (2010) who foundout that, investment in solar technologies for electricity generation saves money since there are no monthly bills after initial investment. The findings however does not corroborate with the findings of Wani and Pandya (2016) who observed that students in Vadodara city do not possess enough knowledge regarding the solar policies and solar technologies. The findings of van Rijinsoever and Farla (2014) revealed that public acceptance is becoming more prominent, due to the development of societies where scientific information is more accessible to the public could justify the reason for high level of awareness among the respondents for this study. Also, Sambo *et al.* (2010) asserted that the massive load shedding that result to most supply of electricity to be for only few hours a day has constituted a major obstacle which undoubtedly has increased the quest for alternative power sources among the teaming populace and has consequently increased the awareness level.

It was found out that there was no significant difference in the mean ratings of the responses of the three groups of respondents as regards to the level of awareness of solar energy technologies for electricity generation and utilisation. The null hypothesis of no significant difference was therefore upheld for the three groups on level of awareness of solar energy technologies for electricity generation and utilisation. The implication of this is that the electrician, residents and MSEs operators did not significantly differ in their opinions on the 22 items. Generally, the findings of the study on hypothesis one were in line with the findings of Adeleke and Akinbode (2016) who found out that there was no significance difference in the mean ratings of the responses of electrician, residents and MSEs operators on electricity generation and utilisation. The findings of Roman and Alan (2016) which revealed that most electricity consumers holds similar opinion on electricity generation and utilization, gave credence to the findings of this study on hypothesis one as regards the level of awarenes of solar energy technologies for electricity generation and utilisation.

The finding relating to research question two showed that the respondents strongly agreed to 5 items and agreed to the remaining 9 items on the attitude of consumers towards utilisation of solar energy technologies for electricity generation. The findings of the study on the attitude of consumers on the utilisation of solar energy technologies are in agreement with the findings of Venkatraman and Sheeba (2014) who observed that people buy solar products for its durability, favorable comments from friends and neighbors among others. To buttress this statement, Ikponmwosa *et al*. (2014) asserted that strong desire for economic independence and knowledge of environmental issues among others are what inform the attitude of consumers on the utilisation of solar energy technologies. Similarly, finding of Faiers and Neame (2006) explained that environmental concerns affect household PV system installation, along with other adoption factors such as financial status, economic concerns, and aesthetic characteristics and was also in line with the result from the interview, which revealed that non-financial reasons such as social or peer influences, attitudes about innovation, environmental preferences technical knowledge, motivation, experiences, and familiarity influences consumers attitude.

It was found out that there was no significant difference in the mean ratings of the responses of the three groups of respondents (54 electrician, 200 residents and 54 MSEs operators) as regards to the attitude of electricity consumers on the utilisation of solar energy technologies for electricity generation. The null hypothesis of no significant difference was therefore upheld for the three groups on attitude of electricity consumers on the utilisation of solar energy technologies for electricity generation.

The finding relating to research question three showed that the respondents strongly agreed to two items while the remaining 22 items were agree base on the perceptions of consumers on the utilisation of solar energy technologies for electricity generation. The findings revealed that some respondents showed positive perceptions towards the utilisation of solar energy technologies while the lower percentages of the respondents have misconceptions about solar energy technologies. Those that expressed positive perception towards solar energy technologies believed that the aesthetic nature of solar technologies is awesome and beautiful, easy to install; solar technologies require no or little maintenance solar technologies have high initial installation cost but has high pay-back benefits. This finding gives credence to the finding of Faiers and Neame (2006) who explained that environmental concerns affect household PV system installation, along with other factors such as financial status, economic concerns, and aesthetic. Similarly those that inhibit some myths and misconceptions of the technologies believed that solar panels and CSP system do not work in cold weather or when it is cloudy. They also believed that solar technologies is not yet mature hence it is only suited for particular markets and will require heavy subsidy to make it viable. The findings of this study corroborate with the finding of Mutungwa (2014) who believed that there are misconception that inhibits the minds of prospective consumers of electricity on the use of solar technologies.

It was found out that there was no significant difference in the mean ratings of the responses of the three groups of respondents (54 electrician, 200 residents and 54 MSEs operators) as regards the perception of electricity consumers on the utilisation of solar energy technologies for electricity generation. The null hypothesis of no significant difference was therefore upheld for the three groups on perception of electricity consumers on the utilisation of solar energy technologies for electricity generation. The implication of this is that the electrician, residents and MSEs operators did not significantly differ in their opinions on the 24 items. Generally, the findings of the study on hypothesis three were in line with the findings of Ikponmwosa *et al*. (2014**)** who found out that there was no significance difference in the mean ratings of the responses of electrician, residents and MSEs operators on electricity generation and utilisation**.** The findings of the Mutungwa (2014) gave credence to the findings of this study on hypothesis three as regards the perception of electricity consumers on the utilisation of solar energy technologies for electricity generation.

The finding relating to research question four showed that the respondents strongly agreed to one item; while the remaining 14 items were agree as a limiting factor affecting the effective utilisation of solar energy technologies for electricity generation. The findings of the study on the factors affecting the effective utilisation of solar energy technologies were in consonance with the findings of Roman and Alan (2016) who revealed that lack of manpower and the desired technological skills to manage new technologies efficiently affects the adoption of a technology. Similarly, the findings of the study is also in line with the findings of Adeleke and Akinbode (2016) who found that absence of establishment and data recording stations amongst others impose serious setbacks on the research and applications of renewable energy related products. The results from the interview support the findings of Sambo (2006) which revealed that the lack of capacity and inadequate expertise to manage the growing renewable energy sources hampers renewable energy growth in most developing countries.

It was found out that there was no significant difference in the mean ratings of the responses of the three groups of respondents (54 electrician, 200 residents and 54 MSEs operators) as regards the factors affecting the effective utilisation of solar energy technologies for electricity generation. The null hypothesis of no significant difference was therefore upheld for the three groups on the factors affecting the effective utilisation of solar energy technologies for electricity generation.

The finding to research question five showed that the respondents agreed to all the ten items as regards to the strategies for the effective utilisation of solar energy technologies for electricity generation. The findings of the study on the strategies for the effective utilisation of solar energy technologies are in consonance with the findings of Abdullahi *et al*. (2022) found out that increased publicity concerning the development, applications, dissemination and diffusion of solar energy resource and technologies through the media, mobile networks, schools can bring about good knowledge of the importance of utilizing solar technologies. Similarly, the findings of Sampaio *et al*. (2017)**,** also agreed with the finding of the study that, revealed that actions such as subsidy of cost of importation of solar PV devices by the government, provision of soft loans and financial assistance by the government and non-governmental organisations to individuals, funding of solar technology researches and development initiatives in higher institutions so as to develop solar PVs with increased efficiency that will be adaptable to our environment among others can increase renewable energy use. In addition, the study of Saka *et al.* (2017) which showed a clear correlation between energy consumption and living standards and the quest for improved power supply in the area could justify the reason for opinions of the respondents on the interventional strategies for effective utilisation of solar engergy.

It was found out that there was no significant difference in the mean ratings of the responses of the three groups of respondents (54 electrician, 200 residents and 54 MSEs operators) as regards the strategies for effective utilisation of solar energy technologies for electricity generation. The null hypothesis of no significant difference was therefore upheld for the three groups on strategies for effective utilisation of solar energy technologies for electricity generation. The implication of this is that the electrician, residents and MSEs operators did not significantly differs in their opinions on the 10 items. Generally, the findings of the study on hypothesis four were in line with the findings of Ikponmwosa *et al*. (2014**)** who it was found out that there was no significance difference in the mean ratings of the responses of electrician, residents and MSEs operators on electricity generation and utilisation**.**

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study investigated consumers' utilisation of solar energy technologies for electricity generation in Kogi State. It is evident from the study that the consumers of electricity in the study area are aware of the potentials of solar energy technologies for electricity generation. This can be attributed to the fact that solar energy technologies have become increasingly more popular due to their economic benefits and in view of the fact that with a battery backup, solar energy can even provide all day long steady supply of electricity. There is no doubt that solar energy has more benefits compared to other forms of energy like fossils fuels and petroleum deposits. It is an alternative which is promise and consistent to meet the high energy demand.

The conclusions drawn from this study therefore, show that large proportions of the respondent demonstrate high awareness, have good attitude and hold positive perception towards solar energy technologies for electricity generation and utilisation. They supported the application of solar technologies in augmenting the current national grid to solving electricity crisis in their communities. More than 70% of the respondents claimed to have electricity supply of less than 6 hours in a day, and 84% of the respondents are willing to pay more for electricity generated from renewable energy once it is regular.

5.2 Recommendations

The following recommendations were made for implementation based on the findings of this study;

1. Government and other renewable stakeholders should commit themselves politically in funding solar energy technologiess as well as training many people on the operations of the technologies so as to develop the capabilities to liberate Nigeria from depending on fossil fuel as the only alternative to generate electricity in various households. This will further create access to diverse energy sources.
2. Kogi state government should also commit itself to creating an enabling environment for the private sectors to operate successfully in using RETs to generate electricity as this will facilitate easier access to electricity in various communities since it has been established that consumers are willing to pay more once there is stable electricity supply.
3. Effective mechanism to check the entry of counterfeits should be put in place by relevant agencies, as counterfeit products affect public confidence in the solar technologies available on the market.
4. The Nigerian government and relevant stakeholders should truly commit itself to diversify energy mix by creating an enabling environment for the private sector to use renewable energy technologies in various communities.
5. There should be provision of soft loans and financial assistance by financial institutions, government and non-governmental organisations to individuals so that people can afford to invest in solar energy technologies.

5.3 Suggestion for Further Studies

The following suggestions were made for further research;

1. Replication of this research in the six geo-political zones of the country is suggested in order to examine whether the attitudes are different or not so as to come up with a robust framework in using renewable energy to provide electricity to the entire Nigerians.
2. Up-skilling needs of solar energy technicians/electricians on installation and maintenance of solar energy technologies work.
3. Assessment of the Viability of solar energy technologies for industrial consumption
4. Competency required by solar energy technicians/electricians on installation and maintenance of solar energy technologies.

5.4 Contribution to Knowledge

The study assessed consumers' utilisation of solar energy technologies for electricity generation in Kogi State Nigeria. The research work contribute to knowledge in the way that it establish the factors that inform the attitude of consumers on the utilisation of solar energy technologies to be strong desire for economic independence and knowledge of environmental issues. It also justified that increased in publicity concerning the development, applications, dissemination and diffusion of solar energy resource and technologies through the media, mobile networks is the reason for high level of awareness of solar energy technologies among electricity consumers.

Furthermore, the study established that non-financial reasons such as social or peer influences, attitudes about innovation, environmental preferences, technical knowledge, motivation, experiences, and familiarity influences consumers attitude. It also established that environmental concerns affect household PV system installation, along with other factors such as financial status, economic concerns, and aesthetic. The research work further established that actions such as subsidy of cost of importation of solar PV devices by the government, provision of soft loans and financial assistance by the government and non-governmental organisations to individuals as well as funding of solar technology researches and development initiatives in higher institutions so as to develop solar PVs with increased efficiency that will be adaptable to our environment among others can increase renewable energy use.

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APPENDICIES

Appendix A

VALIDATION LETTER

Department of Industrial and Technology Education,
Federal University of Technology
Minna, Niger State.
28th May, 2021

Federal University of Technology Minna, Niger state.
Department of Industrial and Technology Education
Sir,

REQUEST FOR RESEARCH INSTRUMENT VALIDATION

Your kind gesture is needed to ascertain the credibility and suitability of this instrument on the **Awareness and attitudess of Consumers on the Utilisation of Solar Energy Technologies for Electricity Generation in Kogi State.**

I therefore request that you validate the attached instruments (questionnaire).

You are obliged to remove or add items (s) necessary for the actualization of the set goal. The proficiency of the project is based on the accuracy of this instrument, and as such, your kind opinions on the above subject matter are highly valuable.

Thank you.

Validated by:

Name: ____

Sign: ____

Date: ____

Yours faithfully,
EkeleOjonugwa Abraham
MTech/SSTE/2018/8798
08167580662

Appendix B

INSTRUMENT FOR DATA COLLECTION

FEDERAL UNIVERSITY OF TECHNOLOGY MINNA, DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION (ITE)

AWARENESS AND ATTITUDESS OF CONSUMERS TO SOLAR ENERGY TECHNOLOGIES FOR ELECTRICITY GENERATION AND UTILISATION QUESTIONNAIRE (APACSETEGUQ).

INSTRUCTION: Please complete this questionnaire as faithfully as possible and sincerely check [√] the column that best represents your perception about each item. Your response will be used only for the purpose of this research.

RESPONDENT'S SATUS:
Resident [ ] MSEs Operator [ ] Solar Energy Technician [ ]

PART II

SECTION A

INSTRUCTIONS: Please read each statement carefully and respond by checking [√] the option you consider appropriate. The options are: Highly Aware (NA), Aware (A), Not Aware (NA), and Highly Not Aware (HNA).

Research Question 1: What is the level of awareness of consumers on solar energy technologies for electricity generation and utilisation?

S/N	ITEMS	HA	A	NA	HNA
1	Solar technologies operation is noiseless				
2	Solar technologies has infinite energy source				
3	Solar technologies has a very high life span				
4	Solar technologies are environmentally friendly in nature with respect to release of greenhouse gases, global warming, ozone layer depletion				
5	Solar energy technologies is convenient, safe and has no monthly bills after initial investment				
6	Solar energy technologies could help address energy access for MSEs and domestic use				
7	Concentrating solar power plants provide the lowest cost power of any solar technology				
8	Photovoltaic (PV) panels are available in different sizes or modules over a wide range of power rating				
9	Concentrated Solar Power will decrease global warming				
10	Investment in solar technologies for electricity generation saves money since there are no monthly bills after initial investment				
11	Generating electrical energy through PV and CSP systems have low operational and maintenance cost				

12	Solar energy technologies produces no smoke like gasoline generators when generating electricity				
13	Solar power plants can last more than 35 years				
14	Solar panels actually work more efficiently in colder temperatures because excessive heat can reduce output voltage				
15	The solar panels generally increases home values				
16	Concentrating solar power system has Shorter energy-payback period.				
17	Solar energy technology can be embraced by people across an entire sociopolitical spectrum				
18	Solar panels are generally sleek, compact and fit neatly against the roof.				
19	Power generated through solar energy technologies can be used for pumping of water and operates electronics appliances				
20	Solar energy technologies allow you to enjoy 24 hours power supply with the aid of battery				
21	With the use of solar technologies, I can power my home when the power from the grid system goes out;				
22	Concentrated Solar Power creates recyclable energy				

SECTION B

INSTRUCTIONS: Please read each statement carefully and respond by checking [√] the option you consider appropriate. The options are: Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD).

Research Question 2: What are the attitudes of consumers on the utilisation of solar energy technologies for electricity generation?

S/N	ITEMS	SA	A	D	SD
1	Adoption of Solar energy technologies for electricity generation is important to me because solar power causes less electricity loss due to absence of long distance transmissions of electric current				
2	Difficulty in installation and lack of technical know-how is the major factor for my non-adoption of solar energy technologies				
3	Durability of solar energy technologies impacts my willingness to adopt solar energy technologies for the generation and utilisation of electricity				
4	Favorable comments from friends and neighbors have significant positive impacts on my willingness to adopt solar energy technologies for the generation and utilisation of electricity				
5	I am not interested in adopting solar technologies because too much maintenance is required				
6	I am willing to adopt solar energy technologies because of my strong desire for economic independence;				
7	I am willing to take low-cost loans to invest in solar power for the				

	generation and utilisation of electricity				
8	I will not adopt solar energy technologies for electricity generation and utilisation I have low information about the new technology				
9	I will only adopt solar energy technologies if I receive financial incentives or supports from governments or non-governmental organization				
10	I will rather adopt solar energy technologies because the technology is safe and environmentally-friendly compared to fossil fuel generator.				
11	My knowledge and belief about costs of renewable energy such as solar energy use is the major factor consider before adopting solar energy technologies				
12	My knowledge of environmental issues is the reason for the willingness to pay for green technologies such as solar power				
13	I am willing to use solar energy technologies to generate and utilize electricity because of poor electricity supply				
14	Solar energy technologies is important to me because it gives me alternative to grid electricity supply				

SECTION C

INSTRUCTIONS: Please read each statement carefully and respond by checking [√] the option you consider appropriate. The options are: Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD).

Research Question 3: What are the perceptions of consumers on the utilisation of solar energy technologies for electricity generation?

S/N	ITEMS	SA	A	D	SD
1	Solar technologies has poor aesthetics				
2	Solar technologies is expensive to purchase				
3	There is lack of government grants for solar technologies investment				
4	Solar technologies require too much maintenance				
5	Solar technologies does not add value to property				
6	Solar technologies is difficult to install				
7	Solar technologies is not yet mature hence it is only suited for particular markets and will require heavy subsidy to make it viable				
8	Solar technologies has High propensity for theft				
9	Solar technologies is not viable for industrial purposes				
10	You can't install a solar Photovoltaic panels yourself				
11	Not all solar panels are of high quality.				
12	Solar Photovoltaic panels and concentrated solar power required large expanse of land for their installation				
13	Photovoltaic panels in Nigeria market are characterized with low efficiencies				

14	There is lack of capacity and inadequate expertise to develop, and manage the solar energy technologies				
15	There are no established standard and quality control systems of both locally and imported manufactured technologies				
16	Solar energy technologies cannot meet energy demands;				
17	Solar panels and CSP system do not work in cold weather or when it is cloudy;				
18	Solar energy is too costly and is not economically viable;				
19	Installing solar is quite complicated and requires a lot of maintenance;				
20	Solar panels will cause damage to your roof;				
21	Reselling your home/facility will be harder with solar panels;				
22	Solar panel prices are based on the size of your home				
23	Solar panels are bad for the environment after their lifetime is used up;				
24	Solar panels are toxic and can't be recycled;				

SECTION D

INSTRUCTIONS: Please read each statement carefully and respond by checking [√] the option you consider appropriate. The options are: Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD).

Research Question 4: What are the limiting factors affecting the effective utilisation of solar energy technologies for electricity generation?

S/N	ITEMS	SA	A	D	SD
1	Absence of establishment such as renewable energy data recording stations amongst others;				
2	High propensity to theft;				
3	Has initial high costs of purchase and installation;				
4	Solar technologies require high up frontal capital cost compared to its conventional energy alternatives;				
5	Solar technologies require large expanse of land for their installation;				
6	Some PV panels are characterized with low efficiencies				
7	absence of equipped laboratories/research centres for solar PV research;				
8	Lack of credit facilities to purchase solar technologies;				
9	Lack of manpower and the desired technological skills to manage solar energy technologies efficiently;				
10	Limited application of solar energy technologies domestically and commercially;				
11	Limited or few service providers of solar energy technical services;				
12	Several counterfeit solar energy technologies goods on the market;				
13	Low level of awareness on the huge health, socio-economic and environmental benefits derivable from solar energy use;				
14	Lack of effective national energy policy				

15	Lack of financial and fiscal incentives towards the utilisation of solar technologies				

SECTION E

INSTRUCTIONS: Please read each statement carefully and respond by checking [√] the option you consider appropriate. The options are: Strongly Agree (SA), Agree (A), Disagree (D), and Strongly Disagree (SD).

Research Question 5: What are the interventional strategies for the effective utilisation of solar energy technologies for electricity generation?

S/N	ITEMS	SA	A	D	SD
1	There is need to put in place an effective mechanism to check the entry of counterfeits, because they affect public confidence in the solar technologies available on the market				
2	Information concerning the development, applications, dissemination and diffusion of solar energy resource and technologies should be stepped up through; the media, mobile networks, schools etc.				
3	Subsidized cost of importation of solar PV devices by Government				
4	Eradication or reduction of poverty level to the Barest minimum by the Government so that people can afford to invest in solar energy technologies				
5	Introduction of renewable energy incentives similar to the “feed-in-tariffs” by the Government to enhance increased consumption of renewable energy such as solar energy;				
6	Provision of soft loans and financial assistance by financial institutions, government and non-governmental organisations to individuals so that people can afford to invest in solar energy technologies;				
7	Sensitization programmeme through mass media to increase the level of awareness on the merit of investment of consumption of renewable energy products such as solar technologies;				
8	Establishment of Research centres on renewable energy technology and properly equipped existing ones;				
9	Placing restrictions on the importation of diesel and petrol engine generators by the government because of its adverse effects on the environment;				

10	Funding of solar technology researches and development initiatives in higher institutions so as to develop solar PVs with increased efficiency that will be adaptable to our environment				

INTERVIEW GUIDE

Research question 1

What is the level of awareness of electricity consumers on solar energy technologies for electricity generation and utilisation?

Interview questions

1. Why is solar energy technologies considered as the right energy source to address energy access for MSEs and domesticity?
2. What are the different sizes or modules of Photovoltaic (PV) panels available to consumers for electricity generation with respect to their power rating?
3. What do you know about Concentrated Solar Power (CSP) system?
4. With respect to socioeconomic and sociopolitical status, what category of persons can venture into the adoption of solar energy technology for electricity generation?
5. With respect to durability of the technology, how long can solar power plants last?
6. In view of the release of greenhouse gases, global warming, ozone layer depletion, why is Solar technologies the best alternative source of energy for electricity generation?

Research question 2

What are the attitudes of electricity consumers towards the utilisation of solar energy technologies for electricity generation?

Interview questions

1. How does the following attitude of electricity consumers affect the adoption and utilisation of solar energy technologies for electricity generation?

- **i.** Strong desire for economic independence
- **ii.** Favorable comments from friends and neighbors (peers influence)
- **iii.** Knowledge of environmental issues
- **iv.** Perceived ease of use

Research question 3

What are the perceptions of electricity consumers towards the utilisation of solar energy technologies for electricity generation?

Interview questions

1. What is your opinion on the following as it affects solar energy technologies?

- **i.** Solar technologies aesthetics

ii. Solar technologies maintenance
iii. Solar technologies installation cost
iv. Photovoltaic panel's efficiency
v. Standard and quality control systems of both locally and imported manufactured technologies

Research question 4

What are the limiting factor affecting the utilisation of solar energy technologies for electricity generation?

Interview questions

What are the limiting factors affecting the utilisation of solar energy technologies for electricity generation known to you?

Research question 5

What are the interventional strategies for the effective utilisation of solar energy technologies for electricity generation?

Interview questions

1. What are some of the interventional strategies that can result to effective utilisation of solar energy technologies for electricity generation?

Appendix C

VALIDATION CERTIFICATE

This is to certify that the instrument on the research work titled: **Awareness, Perceptions and Attitudes of Electricity Consumers on the Utilization of Solar Energy Technologies for Electricity Generation in Lokoja Metropolis.** Was validated by me:

Name of First Validates': Dr. Ilemam G. A.

Institution: FUT Minna

Department: ITE

Signature and Date: 03-06-021

Name of Second validates': T. M. SABA PhD

Institution: FUT MINNA

Department: ITE

Signature and Date: 21/06/2021

Name of Third validates': Dr E. Raymond

Institution: FUT MINNA

Department: ITE Dept

Signature and Date: 22/06/2021

Name of Research Student: Ekele Ojonugwa Abraham

Matriculation Number: M.Tech/SSTE/2018/8798

Programme of Study: M.Tech Industrial and Technology Education (Elect/Elect Technology)

Appendix D

CRONBACH'S ALPHA RELIABILITY STATISTICS

Scale: Research Question 1

Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded[a]	0	.0
	Total	30	100.0

Reliability Statistics

Cronbach's Alpha	N of Items
.796	15

Scale: Research question 2

Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded[a]	0	.0
	Total	30	100.0

Cronbach's Alpha	N of Items
.713	14

Scale: research question 3

Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded[a]	0	.0
	Total	30	100.0

Reliability Statistics

Cronbach's Alpha	N of Items
.817	24

Scale: Research Question 5

Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded[a]	0	.0
	Total	30	100.0

Reliability Statistics

Cronbach's Alpha	N of Items
.821	15

Scale: Research Question 6

Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded[a]	0	.0
	Total	30	100.0

Cronbach's Alpha	N of Items
.734	10

APPENDIX E

LETTER OF INTRODUCTION

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA.

SCHOOL OF SCIENCE AND TECHNOLOGY EDUCATION

DEPARTMENT OF INDUSTRIAL AND TECHNOLOGY EDUCATION

Vice Chancellor:
PROF. ABDULLAHI BALA, FSSSN
B. Agric (A.B.U), M. Sc (Reading), Ph.D (London)

Head of Department:
DR. I. Y. UMAR, MTRCN, MTEPAN
B. Tech, M. Tech (Minna), Ph.D (SWU China)
E-mail: umaryahuba@futminna.edu.ng

P.M.B. 65, Minna
Telephone: +2348066059717
E-mail: ite@futminna.edu.ng
Website: www.futminna.edu.ng

Your Ref.________________

Our Ref.________________

Date 30/08/2021

....

....

....

....

Sir/Ma.

TO WHOM IT MAY CONCERN

The bearer EKELE, Ojonugwa Abraham with Registration Number M.Tech/SSTE/2018/18798........ is A Master student of Industrial and Technology Education Department.

He is carrying out a research titled; Awareness & Attitude of Consumers on the Utilization of Solar Energy Technologies for Electricity Generation in Kogi State.

He needs your assistance to enable him carry out his field work.

We will appreciate your anticipated co-operation.

Thank you.

Dr. R. Audu
Postgraduate Coordinator, ITE.

Appendix F

POPULATION OF THE STUDY

LICENSED ELECTRICAL CONTRACTORS ASSOCIATION OF NIGERIA (LECAN)
(LOKOJA CHAPTER)

18th June, 2021

Industrial Technology Education
Federal University of Technology,
PMB 65 Minna,
Niger State
16th June, 2021.

Dear sir,

RESPONSE LETTER

In response to your request letter seeking to know the number of the registered members of the association, I am directed to inform you that Lokoja chapter of the association has 200 registered members under the following distribution:

Ganaja area	-	60
Felele	-	55
Adankolo	-	43
Otokiti	–	42

Please, note that all information gotten from us must be used for academic purposes only.

Much regards!

Yours Faithfully,

Paul Okehi
LECAN State Secretary.

Office Address: **5, Destiny Plaza, Ganaja Junction, Lokoja, Kogi State**

Appendix G

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Solar technologies operation is noiseless	308	2.00	4.00	3.2240	.86845	.754
Solar technologies has infinite energy source	308	1.00	4.00	3.1169	.94781	.898
Solar technologies has a very high life span	308	1.00	4.00	3.2208	.97357	.948
Solar technologies are environmentally friendly in nature with respect to release of greenhouse gases, global warming, ozone layer depletion	308	2.00	4.00	3.2987	.63687	.406
Solar energy technologies is convenient, safe and has no monthly bills after initial investment	308	3.00	4.00	3.6039	.48988	.240
Solar energy technologies could help address energy access for MSEs and domestic use	308	3.00	4.00	3.5909	.49247	.243
Concentrating solar power plants provide the lowest cost power of any solar technology	308	1.00	4.00	3.2045	.87698	.769
Photovoltaic (PV) panels are available in different sizes or modules over a wide range of power rating	308	2.00	4.00	3.1948	.59398	.353
Concentrated Solar Power will decrease global warming	308	2.00	4.00	3.4026	.66577	.443
Investment in solar technologies for electricity generation saves money since there are no monthly bills after initial investment	308	2.00	4.00	3.2922	.63477	.403
Generating electrical energy through PV and CSP systems have low operational and maintenance cost	308	2.00	4.00	2.8766	.82965	.688
Solar energy technologies produces no smoke like gasoline generators when generating electricity	308	2.00	4.00	3.2987	.77527	.601
Solar power plants can last more than 35 years	308	1.00	4.00	3.0130	.78659	.619

Solar panels actually work more efficiently in colder temperatures because excessive heat can reduce output voltage	308	2.00	4.00	3.1916	.59776	.357
The solar panels generally increases home values	308	3.00	4.00	3.6039	.48988	.240
Concentrating solar power system has Shorter energy-payback period	308	1.00	4.00	3.1981	.97010	.941
Solar energy technology can be embraced by people across an entire sociopolitical spectrum	308	3.00	4.00	3.5097	.50072	.251
Solar panels are generally sleek, compact and fit neatly against the roof	308	2.00	4.00	3.3994	.66037	.436
Power generated through solar energy technologies can be used for pumping of water and operates electronics appliances	308	2.00	4.00	3.4156	.66265	.439
Solar energy technologies allow you to enjoy 24 hours power supply with the aid of battery	308	2.00	4.00	3.0974	.82525	.681
With the use of solar technologies, I can power my home when the power from the grid system goes out	308	2.00	4.00	3.0747	.83740	.701
Concentrated Solar Power creates recyclable energy	308	1.00	4.00	2.7987	1.07309	1.152
Adoption of Solar energy technologies for electricity generation is important to me because solar power causes less electricity loss due to absence of long distance transmissions of electric current	308	2.00	4.00	3.0227	.78013	.609
Difficulty in installation and lack of technical know-how is the major factor for my non-adoption of solar energy technologies	308	2.00	4.00	3.1981	.74615	.557
Durability of solar energy technologies impacts my willingness to adopt solar energy technologies for the generation and utilisation of electricity	308	2.00	4.00	3.1786	.61781	.382

Favorable comments from friends and neighbors have significant positive impacts on my willingness to adopt solar energy technologies for the generation and utilisation of electricity	308	2.00	4.00	3.2013	.74309	.552
I am not interested in adopting solar technologies because too much maintenance is required	308	1.00	4.00	3.3182	.99970	.999
I am willing to adopt solar energy technologies because of my strong desire for economic independence	308	2.00	4.00	3.0000	.76996	.593
I am willing to take low-cost loans to invest in solar power for the generation and utilisation of electricity	308	2.00	4.00	3.3766	.68562	.470
I will not adopt solar energy technologies for electricity generation and utilisation I have low information about the new technology	308	2.00	4.00	2.8994	.69404	.482
I will only adopt solar energy technologies if I receive financial incentives or supports from governments or non-governmental organisation	308	1.00	4.00	3.1104	.94859	.900
I will rather adopt solar energy technologies because the technology is safe and environmentally-friendly compared to fossil fuel generator	308	1.00	4.00	3.0032	.88601	.785
My knowledge and belief about costs of renewable energy such as solar energy use is the major factor consider before adopting solar energy technologies	308	2.00	4.00	3.4123	.66223	.439
My knowledge of environmental issues is the reason for the willingness to pay for green technologies such as solar power	308	1.00	4.00	3.0032	.88601	.785

I am willing to use solar energy technologies to generate and utilize electricity because of poor electricity supply	308	1.00	4.00	3.1136	1.13720	1.293
Solar energy technologies is important to me because it gives me alternative to grid electricity supply	308	2.00	4.00	2.9026	.82525	.681
Solar technologies has poor aesthetics	308	1.00	4.00	3.1818	1.07960	1.166
Solar technologies is expensive to purchase	308	2.00	4.00	3.3929	.65935	.435
There is lack of government grants for solar technologies investment	308	3.00	4.00	3.6071	.48918	.239
Solar technologies require too much maintenance	308	2.00	4.00	3.0974	.69216	.479
Solar technologies does not add value to property	308	2.00	4.00	3.0747	.71120	.506
Solar technologies is difficult to install	308	1.00	4.00	2.9903	.88963	.791
Solar technologies is not yet mature hence it is only suited for particular markets and will require heavy subsidy to make it viable	308	2.00	4.00	3.1104	.70882	.502
Solar technologies has High propensity for theft	308	2.00	4.00	2.8994	.69404	.482
Solar technologies is not viable for industrial purposes	308	1.00	4.00	2.7305	.91073	.829
You can't install a solar Photovoltaic panels yourself	308	1.00	4.00	2.8052	.97244	.946
Not all solar panels are of high quality	308	1.00	4.00	2.5747	1.10563	1.222
Solar Photovoltaic panels and concentrated solar power required large expanse of land for their installation	308	2.00	4.00	2.8019	.59564	.355
Photovoltaic panels in Nigeria market are characterized with low efficiencies	308	1.00	4.00	3.1169	.94091	.885
There is lack of capacity and inadequate expertise to develop, and manage the solar energy technologies	308	2.00	4.00	3.0942	.69496	.483

There are no established standard and quality control systems of both locally and imported manufactured technologies	308	2.00	4.00	3.1721	.75690	.573
Solar energy technologies cannot meet energy demands	308	2.00	4.00	3.1916	.59776	.357
Solar panels and CSP system do not work in cold weather or when it is cloudy	308	2.00	4.00	3.5097	.66795	.446
Solar energy is too costly and is not economically viable	308	2.00	4.00	2.9026	.53258	.284
Installing solar is quite complicated and requires a lot of maintenance	308	2.00	4.00	3.3701	.68441	.468
Solar panels will cause damage to your roof	308	2.00	4.00	3.0000	.44209	.195
Reselling your home/facility will be harder with solar panels	308	2.00	4.00	3.2143	.74819	.560
Solar panel prices are based on the size of your home	308	2.00	4.00	3.0000	.63039	.397
Solar panels are bad for the environment after their lifetime is used up	308	2.00	4.00	3.2727	.65842	.434
Solar panels are toxic and can't be recycled	308	2.00	4.00	3.1948	.59943	.359
Absence of establishment such as renewable energy data recording stations amongst others	308	2.00	4.00	3.3214	.77665	.603
High propensity to theft	308	2.00	4.00	3.1006	.53503	.286
Has initial high costs of purchase and installation	308	2.00	4.00	2.8799	.70493	.497
Solar technologies require high up frontal capital cost compared to its conventional energy alternatives	308	2.00	4.00	3.1006	.53503	.286
Solar technologies require large expanse of land for their installation	308	1.00	4.00	3.1169	.94091	.885
Some PV panels are characterized with low efficiencies	308	1.00	4.00	2.7078	.89461	.800
Absence of equipped laboratories/research centres for solar PV research	308	1.00	4.00	2.9903	.99995	1.000
Lack of credit facilities to purchase solar technologies	308	1.00	4.00	3.1981	.86352	.746

Lack of manpower and the desired technological skills to manage solar energy technologies efficiently	308	3.00	4.00	3.7078	.45552	.207
Limited application of solar energy technologies domestically and commercially	308	2.00	4.00	3.1006	.53503	.286
Limited or few service providers of solar energy technical services	308	2.00	4.00	3.2240	.74751	.559
Several counterfeit solar energy technologies goods on the market	308	2.00	4.00	3.2955	.64093	.411
Low level of awareness on the huge health, socio-economic and environmental benefits derivable from solar energy use	308	2.00	4.00	3.3734	.68502	.469
Lack of effective national energy policy	308	2.00	4.00	3.1981	.74615	.557
Lack of financial and fiscal incentives towards the utilisation of solar technologies	308	1.00	4.00	3.0130	1.00479	1.010
There is need to put in place an effective mechanism to check the entry of counterfeits, because they affect public confidence in the solar technologies available on the market	308	2.00	4.00	3.2987	.63687	.406
Information concerning the development, applications, dissemination and diffusion of solar energy resource and technologies should be stepped up through; the media, mobile networks, schools etc	308	2.00	4.00	3.2727	.65842	.434
Subsidized cost of importation of solar PV devices by Government	308	2.00	4.00	3.1981	.59564	.355
Eradication or reduction of poverty level to the Barest minimum by the Government so that people can afford to invest in solar energy technologies	308	2.00	4.00	3.4123	.66223	.439

Introduction of renewable energy incentives similar to the "feed-in-tariffs" by the Government to enhance increased consumption of renewable energy such as solar energy	308	2.00	4.00	3.1006	.69872	.488
Provision of soft loans and financial assistance by financial institutions, government and non-governmental organisations to individuals so that people can afford to invest in solar energy technologies	308	1.00	4.00	2.9253	1.05126	1.105
Sensitization programmeme through mass media to increase the level of awareness on the merit of investment of consumption of renewable energy products such as solar technologies	308	1.00	4.00	2.8052	.74482	.555
Establishment of Research centres on renewable energy technology and properly equipped existing ones	308	1.00	4.00	2.6851	.99911	.998
Placing restrictions on the importation of diesel and petrol engine generators by the government because of its adverse effects on the environment	308	1.00	4.00	2.6006	.91295	.833
Funding of solar technology researches and development initiatives in higher institutions so as to develop solar PVs with increased efficiency that will be adaptable to our environment	308	2.00	4.00	3.4058	.79957	.639
Valid N (listwise)	308					

HYPOTHESES ONE

Descriptives

level of awareness of consumers on solar energy technologies

		N	Mean	Std. Dev	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum	Between-Component Variance
Resident		200	71.6000	4.18540	.29595	71.0164	72.1836	63.00	78.00	
MSEs		54	71.6481	4.34006	.59061	70.4635	72.8328	63.00	78.00	
Electrician		54	71.7037	4.12370	.56116	70.5782	72.8293	63.00	78.00	
Total		308	71.6266	4.18858	.23867	71.1570	72.0963	63.00	78.00	
Model	Fixed Effects			4.20210	.23944	71.1555	72.0978			
	Random Effects				.23944[a]	70.5964[a]	72.6568[a]			-.21877

a. Warning: Between-component variance is negative. It was replaced by 0.0 in computing this random effects measure.

Test of Homogeneity of Variances

level of awareness of consumers on solar energy technologies

Levene Statistic	df1	df2	Sig.
.070	2	305	.087

ANOVA

level of awareness of consumers on solar energy technologies

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.488	2	.244	.014	.986
Within Groups	5385.574	305	17.658		
Total	5386.062	307			

HYPOTHESIS TWO

Descriptives

attitudes of consumers on the utilisation of solar energy technologies

		N	Mean	Std. Dev.	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	Between-Component Variance
						Lower Bound	Upper Bound			
Resident		200	43.7200	4.39982	.31111	43.1065	44.3335	35.00	52.00	
MSEs		54	43.8519	4.44848	.60536	42.6377	45.0661	35.00	52.00	
Electrician		54	43.7037	4.34646	.59148	42.5173	44.8901	35.00	52.00	
Total		308	43.7403	4.38506	.24986	43.2486	44.2319	35.00	52.00	
Model	Fixed Effects			4.39910	.25066	43.2470	44.2335			
	Random Effects				.25066[a]	42.6617[a]	44.8188[a]			-.23793

a. Warning: Between-component variance is negative. It was replaced by 0.0 in computing this random effects measure.

Test of Homogeneity of Variances

attitudes of consumers on the utilisation of solar energy technologies

Levene Statistic	df1	df2	Sig.
.005	2	305	.085

ANOVA

attitudes of consumers on the utilisation of solar energy technologies

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.827	2	.413	.021	.979
Within Groups	5902.394	305	19.352		
Total	5903.221	307			

Robust Tests of Equality of Means

attitudes of consumers on the utilisation of solar energy technologies

	Statistic[a]	df1	df2	Sig.
Brown-Forsythe	.021	2	152.161	.979

a. Asymptotically F distributed.

Post Hoc Tests

Multiple Comparisons

Dependent Variable: attitudes of consumers on the utilisation of solar energy technologies

	(I) Respondent's Status	(J) Respondent's Status	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Tukey HSD	Resident	MSEs	-.13185	.67464	.979	-1.7208	1.4571
		Electrician	.01630	.67464	1.000	-1.5726	1.6052
	MSEs	Resident	.13185	.67464	.979	-1.4571	1.7208
		Electrician	.14815	.84661	.983	-1.8458	2.1421
	Electrician	Resident	-.01630	.67464	1.000	-1.6052	1.5726
		MSEs	-.14815	.84661	.983	-2.1421	1.8458
LSD	Resident	MSEs	-.13185	.67464	.845	-1.4594	1.1957
		Electrician	.01630	.67464	.981	-1.3112	1.3438
	MSEs	Resident	.13185	.67464	.845	-1.1957	1.4594
		Electrician	.14815	.84661	.861	-1.5178	1.8141
	Electrician	Resident	-.01630	.67464	.981	-1.3438	1.3112
		MSEs	-.14815	.84661	.861	-1.8141	1.5178

Homogeneous Subsets

attitudes of consumers on the utilisation of solar energy technologies

	Respondent's Status	N	Subset for alpha = 0.05
			1
Tukey HSD[a,b]	Electrician	54	43.7037
	Resident	200	43.7200
	MSEs	54	43.8519
	Sig.		.978

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 71.366.

b. The group sizes are unequal. The harmonic mean of the group sizes is used.

Type I error levels are not guaranteed.

HYPOTHESIS THREE

Descriptives

perceptions of consumers on the utilisation of solar energy technologies

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	Between-Component Variance
						Lower Bound	Upper Bound			
Resident		200	74.3150	3.88216	.27451	73.7737	74.8563	69.00	84.00	
MSEs		54	74.1852	3.91453	.53270	73.1167	75.2536	69.00	84.00	
Electrician		54	74.3889	3.86770	.52633	73.3332	75.4446	69.00	84.00	
Total		308	74.3052	3.87311	.22069	73.8709	74.7395	69.00	84.00	
Model	Fixed Effects			3.88530	.22139	73.8696	74.7408			
	Random Effects				.22139[a]	73.3527[a]	75.2577[a]			-.18227

a. Warning: Between-component variance is negative. It was replaced by 0.0 in computing this random effects measure.

Test of Homogeneity of Variances

perceptions of consumers on the utilisation of solar energy technologies

Levene Statistic	df1	df2	Sig.
.001	2	305	.061

ANOVA

perceptions of consumers on the utilisation of solar energy technologies

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1.175	2	.588	.039	.962
Within Groups	4604.136	305	15.096		
Total	4605.312	307			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: perceptions of consumers on the utilisation of solar energy technologies

	(I) Respondent's Status	(J) Respondent's Status	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Tukey HSD	Resident	MSEs	.12981	.59584	.974	-1.2735	1.5331
		Electrician	-.07389	.59584	.992	-1.4772	1.3294
	MSEs	Resident	-.12981	.59584	.974	-1.5331	1.2735
		Electrician	-.20370	.74773	.960	-1.9648	1.5573
	Electrician	Resident	.07389	.59584	.992	-1.3294	1.4772
		MSEs	.20370	.74773	.960	-1.5573	1.9648
LSD	Resident	MSEs	.12981	.59584	.828	-1.0427	1.3023
		Electrician	-.07389	.59584	.901	-1.2464	1.0986
	MSEs	Resident	-.12981	.59584	.828	-1.3023	1.0427
		Electrician	-.20370	.74773	.785	-1.6751	1.2677
	Electrician	Resident	.07389	.59584	.901	-1.0986	1.2464
		MSEs	.20370	.74773	.785	-1.2677	1.6751

Homogeneous Subsets

perceptions of consumers on the utilisation of solar energy technologies

	Respondent's Status	N	Subset for alpha = 0.05
			1
Tukey HSD[a,b]	MSEs	54	74.1852
	Resident	200	74.3150
	Electrician	54	74.3889
	Sig.		.947

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 71.366.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

HYPOTHESES FOUR

Descriptives

limiting factors affecting the effective utilisation of solar energy

	N	Mean	Std. Dev.	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	Between-Component Variance
					Lower Bound	Upper Bound			
Resident	200	47.3050	4.76608	.33701	46.6404	47.9696	35.00	54.00	
MSEs	54	47.4074	4.70856	.64075	46.1222	48.6926	35.00	54.00	
Electrician	54	47.3333	4.65002	.63279	46.0641	48.6025	35.00	54.00	
Total	308	47.3279	4.72083	.26899	46.7986	47.8572	35.00	54.00	
Fixed Effects			4.73613	.26987	46.7969	47.8590			
Random Effects				.26987[a]	46.1668[a]	48.4891[a]			-.27899

a. Warning: Between-component variance is negative. It was replaced by 0.0 in computing this random effects measure.

Test of Homogeneity of Variances

limiting factors affecting the effective utilisation of solar energy

Levene Statistic	df1	df2	Sig.
.018	2	305	.057

ANOVA

limiting factors affecting the effective utilisation of solar energy

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	.448	2	.224	.010	.990
Within Groups	6841.432	305	22.431		
Total	6841.880	307			

Robust Tests of Equality of Means

limiting factors affecting the effective utilisation of solar energy

	Statistic[a]	df1	df2	Sig.
Brown-Forsythe	.010	2	153.901	.990

a. Asymptotically F distributed.

Post Hoc Tests

Multiple Comparisons

Dependent Variable: limiting factors affecting the effective utilisation of solar energy

	(I) Respondent's Status	(J) Respondent's Status	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Tukey HSD	Resident	MSEs	-.10241	.72632	.989	-1.8130	1.6082
		Electrician	-.02833	.72632	.999	-1.7390	1.6823
	MSEs	Resident	.10241	.72632	.989	-1.6082	1.8130
		Electrician	.07407	.91147	.996	-2.0726	2.2208
	Electrician	Resident	.02833	.72632	.999	-1.6823	1.7390
		MSEs	-.07407	.91147	.996	-2.2208	2.0726
LSD	Resident	MSEs	-.10241	.72632	.888	-1.5316	1.3268
		Electrician	-.02833	.72632	.969	-1.4576	1.4009
	MSEs	Resident	.10241	.72632	.888	-1.3268	1.5316
		Electrician	.07407	.91147	.935	-1.7195	1.8676
	Electrician	Resident	.02833	.72632	.969	-1.4009	1.4576
		MSEs	-.07407	.91147	.935	-1.8676	1.7195

Homogeneous Subsets

limiting factors affecting the effective utilisation of solar energy

	Respondent's Status	N	Subset for alpha = 0.05
			1
Tukey HSD[a,b]	Resident	200	47.3050
	Electrician	54	47.3333
	MSEs	54	47.4074
	Sig.		.991

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 71.366.

b. The group sizes are unequal. The harmonic mean of the group sizes is used.

Type I error levels are not guaranteed.

HYPOTHESIS FIVE

Descriptives

interventional strategies for the effective utilisation of solar energy

		N	Mean	Std. Dev.	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum	Between-Component Variance
						Lower Bound	Upper Bound			
Resident		200	30.6800	2.86332	.20247	30.2807	31.0793	24.00	35.00	
MSEs		54	30.6667	2.80834	.38217	29.9001	31.4332	24.00	35.00	
Electrician		54	30.8333	2.85994	.38919	30.0527	31.6139	24.00	35.00	
Total		308	30.7045	2.84457	.16208	30.3856	31.0235	24.00	35.00	
Model	Fixed Effects			2.85325	.16258	30.3846	31.0245			
	Random Effects				.16258[a]	30.0050[a]	31.4041[a]			-.09541

a. Warning: Between-component variance is negative. It was replaced by 0.0 in computing this random effects measure.

Test of Homogeneity of Variances

interventional strategies for the effective utilisation of solar energy

Levene Statistic	df1	df2	Sig.
.031	2	305	.096

ANOVA

interventional strategies for the effective utilisation of solar energy

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1.094	2	.547	.067	.935
Within Groups	2483.020	305	8.141		
Total	2484.114	307			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: interventional strategies for the effective utilisation of solar energy

	(I) Respondent's Status	(J) Respondent's Status	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Tukey HSD	Resident	MSEs	.01333	.43757	.999	-1.0172	1.0439
		Electrician	-.15333	.43757	.935	-1.1839	.8772
	MSEs	Resident	-.01333	.43757	.999	-1.0439	1.0172
		Electrician	-.16667	.54911	.950	-1.4599	1.1266
	Electrician	Resident	.15333	.43757	.935	-.8772	1.1839
		MSEs	.16667	.54911	.950	-1.1266	1.4599
LSD	Resident	MSEs	.01333	.43757	.976	-.8477	.8744
		Electrician	-.15333	.43757	.726	-1.0144	.7077
	MSEs	Resident	-.01333	.43757	.976	-.8744	.8477
		Electrician	-.16667	.54911	.762	-1.2472	.9139
	Electrician	Resident	.15333	.43757	.726	-.7077	1.0144
		MSEs	.16667	.54911	.762	-.9139	1.2472

Homogeneous Subsets

interventional strategies for the effective utilisation of solar energy

	Respondent's Status	N	Subset for alpha = 0.05
			1
Tukey HSD[a,b]	MSEs	54	30.6667
	Resident	200	30.6800
	Electrician	54	30.8333
	Sig.		.935