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DIFFUSION OF SOLAR PRODUCTS ON THE AFRICAN MARKET – Case: Ghana

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ABSTRACT

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Solar energy is one of the numerous renewable energy sources that can be relied upon when thinking about the provision of sustainable energy to the vast majority of people living in the developing countries who are yet to have access to clean and sustainable energy. The potentials of solar energy has not been realized yet in the developing Sub-Saharan African countries like Ghana due to several barriers which impede the penetration and diffusion of solar products into the African market and Ghana for that matter. Meanwhile, a research on the energy system in Ghana shows that many consider solar power as an alternative energy source due to the unreliable nature of the sources of power in the country, mainly hydro and thermal power plants.

This research studied the major barriers that impede the penetration and diffusion of solar products into the African market(s) and the case country in the study was Ghana, West Africa. The solutions to the identified barriers have also been captured in the work with some recommendations.

Keywords: Renewable Energy, Ghana, Barriers, Africa, Power.

ABSTRACT

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Aurinkoenergia on yksi monista uusiutuvista energialähteistä. Siihen voidaan turvautua kun silloin, halutaan tuottaa ympäristöä säästävää energiaa valtaosalle kehitysmaissa asuville ihmisille, joilla ei vielä ole mahdollisuutta puhtaaseen ja ympäristöä säästävään energiaan. Aurinkoenergian potentiaalisuutta ei ole vielä ymmärretty kehittyvissä Saharan alapuolella sijaitsevissa maissa kuten Ghanassa. Tämä johtuu useista esteistä, jotka hidastuttavat tuotteiden pääsemisen ja leviämisen Afrikan maihin, tässä yhteydessä Ghanaan. Tutkimus Ghanan energiasysteemistä osoittaa, että monet pitävät aurinkoa vaihtoehtoisena energialähteenä johtuen maan epäluotettavista luontaisista energialähteistä, pääasiassa vesi- ja lämpövoimasta.

Tämä tutkimus käsittelee suurimmat esteet, jotka hidastuttavat tuotteiden pääsemisen ja leviämisen Afrikan maihin, tässä yhteydessä Ghanaan. Tässä työssä on esitelty ratkaisuja ja muutamia suosituksia esteiden selvittämiseksi.

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1 1. INTRODUCTION

1.1 Background

Energy has become an essential ‘commodity’ in our modern day society. Whether a nation is developed or undeveloped it can only function well if energy is prevalent. However, threats of global warming, acidification and nuclear accidents have made it possible to transform the energy we already have into a new focus since the demand for energy is fast growing (Tester, Drake, Driscoll, Golay & Peter 2005). Essential to development and without energy, countries cannot achieve the Millennium Development Goal.

Renewable energy has become one of the strongest partners to improve the plight of about two billion people around the world who are living in mostly rural areas and have no access to any form of energy which is considered as modern. It is estimated that about half a billion people also have limited or unreliable access to energy. It must be noted that these people are living the most remote parts of the world where population growth is on the increase. If there is any difference to be made in the lives of these people then it must be a way of helping them to get connected to power sources. In spite of development in technology and economic viability of so many applications, renewable energy has been utilized to a small fraction of the total potentials it has. This is because of the presence of so many barriers to the penetration of renewable energy products. The barriers to renewable energy products may differ within technologies across countries. This research focuses on the identification of these barriers and if possible how to overcome them.

Since the beginning of the 1980s, the rate of growth in the use of solar power for domestic purposes has shown that the use of solar energy is both mature and technically reliable (James & James 2003).

This research is about the diffusion of solar systems in the African market and the case country is Ghana in West Africa. It is to provide empirical evidence on the critical factors that influence the success of energy products in Ghana and if possible the neighboring countries, which are Togo, Burkina Faso and La Côte d'Ivoire.

1.1 Objectives of the research

The background for this project is to provide evidence on the driving forces and the barriers of the diffusion of solar energy products in Ghana. There is lack of information on the market potential and the characteristics of the solar product in Ghana. As I have already indicated this research attempts to provide empirical evidence on the critical factors that influence the success of energy products in Africa and for that matter, Ghana. It intends to highlight certain aspects of the social, economic and cultural factors that can be instrumental when it comes to diffusing solar products in Ghana. The significance of these factors makes it relevant for firms to understand which types of factors are dominant. With an increasing number of firms wanting to introduce and sell different energy products to Africa, this research which is looking at the energy market, is timely. Results of this study could help firms to adopt marketing and financial policies that would increase the diffusion of solar energy products on the African market.

1.2 The research questions

This research will look critically into the following questions with respect to the diffusion of solar products on the African market and Ghana.

- What are the barriers to obtaining a solar product in Ghana?
- What is the extent of growth of the solar business in Ghana?
- What are the important forces driving the solar business in Ghana?
- What are the characteristics of selecting a solar brand in Ghana?

1.3 Methodology of the research

The study on diffusion of solar products in Ghana was based on a scheme involving three groups of stake holders which are those associated with,

- The scientific and technical community,
- The solar industry,
- Users/Consumers, mainly households and hotels.

The methodological approach which was applied in this work was field research, principally based on the preparation and use of a number of questionnaires, addressed to major diffusion stakeholders.

1.4 Limitations of the research

This research is limited to the study of barriers and driving forces of the solar products on the African market but not the manufacturing of solar products.

1.5 Structure of the research

Chronologically, the research begins with the introduction of the subject by stating the background information and the objective of the research, followed by the research questions and the limitations of the research. Secondly, the literature review or the theoretical framework which leads to the information on the subject as gathered from already existing books and articles. Moreover, the theoretical framework talks about how successful it will be to diffuse solar products in Ghana.

2 LITERATURE REVIEW

2.1 The geography and history of Ghana

Ghana is located at the centre of the West African coast and shares about 2,093 km of land borders with the three French speaking countries namely, Burkina Faso to the north, Côte d'Ivoire to west and Togo to the east. The southern part of Ghana is where the Gulf of Guinea and the Atlantic Ocean are located.

The total land area of Ghana is about 238,533 square kilometers, which is about the same size as that of United Kingdom. The Cape Three points is 4 degrees 30' north of the equator and lays southernmost part of Ghana. The Greenwich meridian passing through London also passes through the eastern part of Ghana at Tema.

The Medieval period is an important part of the history of Ghana. The Republic of Ghana got her name from the then Ghana Empire of West Africa which was formerly called Wagadugu. The empire was controlled by Sundiata in the year 1240 AD and was later on added to the lager Mali Empire when the Mali Empire rose to its peak during the reign of Mansa Musa around the year 1307 AD.

In terms of location, the old Ghana lies about 500 miles north of the present Ghana and it occupies a certain area between the rivers of Senegal and Niger. Ghana still has some inhabitants whose ancestors were linked to the Medieval Ghana which can be traced to the Mande and Voltaic people of today's Northern Ghana. The Gold Coast and European Exploration can also not be left out of the history of Ghana. The history of Ghana cannot be written without some of these major events. Ghana was named as "Gold Coast" before 1957. This was due to the large deposits of gold that the Portuguese came to meet during the 15th century between the banks of the rivers of Ankobra and the Volta and the place was named as Mina or mine. Some years later, the place was named as Gold coast by the British colonizers. So the name Gold Coast actually came from the British who later became the colonial masters of Ghana (<http://www.ghanaweb.com/GhanaHomePage/history/>).

The map of Ghana



Figure 1

Source: <http://www.wordtravels.com/Travelguide/Countries/Ghana/Map>

In the year 1471, a Portuguese expedition arrived in Ghana the then Gold Coast led by Don Diego d' Azambuja who was also sent by King John II with the intention of trading in gold, ivory and slaves, By the year 1482, they had build a castle.

The Portuguese were later accompanied by the Dutch in the year 1598 and they also built forts at Komenda and Kormantsi, all in the central region of Ghana today. In the years 1637 and 1642, the Dutch took over the castle and the fort of Axim from the Portuguese. Other European traders who came to trade in the West

African country were the Danes, English, and the Swedes, who built forts all over the coastline. In the year 1874 when the Dutch left, Ghana was transformed into a British colony.

2.1.1 The climatic conditions in Ghana

The weather in Ghana is mainly tropical throughout the year and as a result, it makes Ghana generally warm most of the year. The temperatures in the various months differ from month to month but the rainy season lasts more than a month.

The weather conditions in Ghana are similar or the same as what is found in the other African nations, especially the neighboring countries but one of the main characteristics of the climate in Ghana is the rainy seasons. The rainy season in Ghana starts from May or June and the second one starts in October especially in southern Ghana along the coast but there is only one rainy season in the northern part of Ghana, which starts also in June. One thing which is very unique about the climatic conditions in Ghana is the uneven distribution of rainfall.

2.1.2 The history of electrical generation in Ghana

The history behind the production of electrical power in Ghana has been divided into three different stages which start from the colonial era. The second stage is the period of the construction of the Akosombo Hydroelectric Power Plant in the year 1966 to the mid 1980s. This period is also referred to as the Volta Development era which includes the commissioning of the Akosombo Hydroelectric Power Plant in the year 1966 and also the commissioning of the Kpong Hydroelectric Power Plant in the year 1982 (Brew-Hammond, 1994).

The first stage was the period when the generation of power was done in isolation with low rates of electrification and by the second stage, which is around the mid-1980s; the demand for power in the country exceeded the capabilities of both the Akosombo Hydroelectric Power Plant and that of the Kpong Plant.

The third stage is what is referred to as the Thermal complementation period. This is the period which has seen the establishment of the Aboadze thermal plant near Takoradi as well as the development of the West Africa gas pipeline to provide a secure and affordable fuel source for power generation within the West African sub-region. There have been efforts by the government of Ghana to link the transmission lines with the neighboring countries including Togo-Benin and the La Cote d'Ivoire interconnection (Ghana Energy Commission, 2006).

2.2 Before the construction of Akosombo

During the period between 1914 – 1966 that is before the construction of the Akosombo Hydroelectric Power Plant, power production and the supply of electricity in Ghana were done with different single generators which were isolated and scattered in different parts of the country. These generators were owned by different establishments in the industrial sector such as mining companies and factories including some institutions like hospitals, schools and municipalities. The first public power supply in Ghana was in 1914 at Sekondi when Ghana was known as the Gold Coast, then Railway Corporation were using the electricity to enhance their operations at night and in the year 1928, the power was extended from Sekondi to Takoradi which is less than 10km. After the extension, the operations of the railway administration within the Sekondi and Takoradi metropolis became very effective (IEA, 1995).

Another company which also operated a public electricity system in addition to the Railway Administration at the time was the Public Works Department (PWD) which supplied Direct Current (DC) to Accra in the year 1922 but on the 1st of November, 1924 they started supplying Accra with Alternating Current (AC).

On April 1, 1926 the supply of electricity started in Koforidua on oil powered engines and in Kumasi public lighting started on May 27, 1927 but it was restricted to evening supply until it became fully operational on October 1, 1927. In 1927 the Winneba municipality was among some selected municipalities that were operating on some form of electricity. It was later changed to Alternating Current (AC) by an extension from Swedru. The Tamale Township was connected

to electricity during the 1929 – 1930 time frames, but it was on a limited nature. Later in 1938; a power station which was operating on an Alternating Current was commissioned (IEA 2002). In the year 1932, a power station was established in Cape Coast and another station was opened in Swedru in 1948.

The year 1948 saw a significant expansion in the electricity system in Ghana. It was when towns like Bolgatanga, Dunkwa on Offin and Akim Oda power stations were established. According to history, the first major electrical transmission extension in the country was an 11kV overhead extension from Tema to Nsawam in the year 1949. Later on in the year 1955, another power station was commissioned in Keta.

In those days, the electricity department, as it was then called, was created not under the Ministry of Energy but rather, the Ministry of Works and Housing. This department was purposely created to take over the operations of public electricity supplies from the Railways Administration and the Public Works Department (PWD). This department undertook a number of projects and one of the main projects was the construction of the Tema diesel power plant which was built in 1956 with an initial capacity of 1.95 MW (3x650 kW units) which was later on expanded to 35MW with an addition of ten 3MW diesel generators, all within the years of 1961 – 1964.

2.3 Different types of renewable energy sources

Energy is one of the essential needs of a functioning society. The scale of its use is closely associated with its capabilities and the quality of life that its members experience. However, threats of global warming, acidification and nuclear accidents have made it possible to transform the existing global energy into a new focus, especially since the demand for energy is fast growing (Tester, Drake, Driscoll, Golay & Peter, 2005).

2.3.1 Technical analysis

With the mission and purpose of this research, which is to find out how feasible it will be to diffuse solar systems on the African market and, Ghana I would like to take a look at all the renewable energy technologies and then narrow everything down on solar energy as the main topic of the analysis.

2.3.2 Geothermal energy

Geothermal power is the energy extracted from the heat that has been stored under the surface of the earth. This originates from the original formation of the planet, from the radioactive decay of minerals and from the solar energy which is absorbed at the surface. (Werner Weiss, 2003).

2.3.3 Wind energy

Wind as an energy is based on converting kinetic energy from the movement of air to electricity through windmills. It is a renewable energy source and environmentally friendly, although some people think it disturbs the local environment because it produces noise, and changes airflow. Windmills are also tall and visible, which is of disturbance to the community and natural experience for tourism. The fact that the intensity of wind in Ghana is centered on the mountains of Amedzofe in the Volta region of Ghana means that the power loss would be too much if energy is to be transferred to other parts of the country, unless the focus is on only Amedzofe Township (IEA, 1996).

2.3.4 Hydropower

Hydro power is a form of electricity which is derived from the energy of running or flowing water by converting mechanical energy into potential energy. Hydro power is an environmentally friendly type of energy which comes from a renewable source because it uses kinetic energy of the water in motion to create other forms of energy, which is usually electricity. (Opam & Turkson, 2000) Hydro electricity has been the most widely used form of energy in Ghana since the establishment of the Akosombo and the Kpong Hydro Power Plants in the

year 1966 but today, due to global warming, the level of the water is always below the maximum level, even if it is rainy season. Hence, the need to look for other forms of energy which will be of advantage to the country due to its location and climatic conditions.

2.3.5 Biogas

Biogas is actually a mixture of many gases, and the main constituents are methane and carbon dioxide. Ammonium, hydrogen sulphide and hydrogen can be found in biogas, but only in small amounts. The other principal type of biogas is wood gas which is created by gasification of wood or other biomass. This type of biogas is comprised primarily of nitrogen, hydrogen, and carbon monoxide, with trace amounts of methane. (Nordex Project, 2009)

2.3.6 Biomass

Biomass is a term which is used to describe organic materials that have become residues and they are mainly from plants and animals. Biomass from fossil energy carriers begins with peat; biomass has been grouped into two categories namely primary and secondary products. The primary products come from direct photosynthetic exploitation of solar energy which includes the entire phytoplankton, e.g. agricultural and forestry products such as fast-growing trees, energy grass, vegetable residues, waste from agricultural including straw and residual wood from forest and industry. (Martin Kaltschmitt, Wolfgang Streicher, & Andreas Wiese, 2007) The secondary products of biomass are formed by decomposition of organic matter other organisms like animals, e.g. manure, solid waste, kitchen waste and garbage.

2.3.7 Solar Energy

Solar energy is a type of energy which comes from direct sunshine. It is produced by converting the sunshine into thermal or electrical energy. There are two types of solar energy which are being used today. These are the thermal and photovoltaic. The thermal type uses energy from the sun to generate heat and solar panels which are used to store the heat and then it is released to buildings for

domestic purposes. (Solar Energy History, <http://www.go-solar.net/?s=thermal>, 2010). The photovoltaic type of solar uses the process of turning energy from the sun into electrical power by using cells. These cells will change the solar energy into a direct current (DC) voltage which is usually stored in batteries and then converted into an alternating current (AC) Voltage, the type of voltage that is used to supply our homes. When solar cells turn light energy from the sun into electricity, it is then used to power equipment which uses solar power to operate, such as calculators, bulbs, radios and others. (<http://www.go-solar.net/tag/photovoltaic-cells/>, 2010). Solar electricity as a means of alternative energy is about a decade behind wind electricity in development for commercial applications but solar energy stands for an important future energy source especially for niche markets like off grid power. It depends on the availability of sunlight and it is dependent on storage. There are some rural applications of solar energy already used in various places in Ghana in the form of photovoltaic cells used to charge batteries and to generate direct use of electricity. (http://www.eia.doe.gov/country/country_energy_data.cfm?fips=GH, 2010)

2.4 Why Solar Energy as an alternative energy source for Ghana

Working on this research so far and reading through the various forms of energy and their application, It has come to the reason as to why solar energy is the preferred form of alternative source of energy for Ghana and her environs. Looking at the geography and location of Ghana, and more importantly the intensity of sunlight in that part of the globe and Ghana has approximately 2370 hours of sunlight annually, (<http://www.readandsubmitarticles.com/ghana-climate-temperature-mean-weather/>, 2010) which is very efficient for the production of solar energy as an alternative energy source for the country especially in the dry season which begins from mid November to the ending of

March. During this period, that is when most of the water bodies in the country get dried up and it affects the Volta River, the river on which the hydropower plant, the main producer of electric power in Ghana is built upon. During the dry season, the water level in the banks of river Volta goes down drastically and the country has to resort to load shedding which makes power distribution to be based on the availability of power. This is the time when parts of the country will be in power while other parts will be in darkness and the following day or two, it becomes vice versa and it is within this period that the solar energy can be very beneficial to the Ghanaian economy as an alternative energy source as hydropower production is lower and there is more sunlight during that same period.

3 RESEARCH METHODOLOGY

For any organization to be successful, both individual entrepreneurs and corporate institutions have to carry out a detailed research so that they can make strategic decisions which will lead to successful business ventures. Talking about research, it is a process whereby data is collected and the collected data is analyzed into pieces of information that will help the researcher to make informed decisions. After the decisions are made, the research findings are then interpreted into ideas which can help anyone who wants to venture into that same area of research. Research is very important in both academic and business environments. It helps the academia and the organizational environments to be abreast with current trend of issues that affect them one way or the other. The research method of the study makes available all important activities in the study, which is in design and strategy. This same part of the study introduces the collection, analysis and discussion of empirical data.

3.1 Quantitative Research

Quantitative research is the type of research where questionnaires are structured with the idea of getting some information from the respondents. In this type of

research, the researcher prepares the questionnaire with the expected answers in mind. Normally the researcher should be well informed about the topic at hand. With this particular method it can also be used to explain the measurement of a market size, brand names, purchase frequencies, awareness level of brands etc. The data should be accurate so that the intended aim can be achieved. In most cases, there must be a sample which reflects the situation in the general population or market. Quantitative research method, unlike qualitative method, provides the researcher with solid and concrete information with facts and figures to support it. (Hague et al 2004).

This particular research strategy was used to gather information from various individuals who own houses, businesses and corporate organizations, even solar industry experts who are all potential users of solar energy so that to find out the reasons why the adaptation of solar energy as an alternative energy source in Ghana has remained slow.

3.2 Qualitative Research

In qualitative research the understanding of the subject is paramount to the accuracy of measurements. In qualitative research, the questions are unstructured and also they use smaller sample size to provide insight. The respondents provide their views, ideas, feelings and others in the best of their knowledge but in quantitative research, the researcher can design the questionnaires even if he or she has not got much knowledge about the subject at hand. In this method it is only the thoughts of the respondents that are gathered. In the case of consumer behavior towards brands, for example, the researcher who uses the qualitative research method can only know a particular view that the consumers have about the product but the quantitative researcher could tell the number of consumers that have that view. Another example can be that a product X is more attractive to consumers than product Y (Quantitative Information). But how product X works as a good product to consumers and why it is attractive to consumers than Y? Qualitative research in this case looks at the issue at hand. That is describing how attractive the product is to the individual consumer (Paul Hague, Nick Hague and Carol-Ann Morgan, Market research in Practice)

3.3 Data Collection

In research, there are two different types of data which are primary and secondary data. Primary data is the type of data which is not already in existence but the researcher gathers and uses it fresh. Primary data demands that, the researcher investigates and keeps records of his findings on that particular topic. Primary data is mostly used in studies where new ideas and theories are brought up and empirically established. In other words, secondary data is already existing information that has been collected by other researchers that are seen to be valid. Secondary data as it is may not have been collected for the same research being conducted at present but it is for different studies. References of secondary data may include the following, annual report, journals, internet sources and other publications.

3.4 Research Design

Research design is the process of gathering and analyzing information. It can be shown by the type of research being conducted. It includes the establishment of the validity and reliability of the research. The reason for the research design is to show the connection that lies between the research questions, the information at hand and the conclusion to arrive at. (Yin, 1994).

In the research design, processes used in the research are well shown including the gathering and analysis of the information. In this research, the researcher used structured questionnaires and some individual interviews. The questions that were used in the questionnaires were able to bring out the views of individual respondents which helped the researcher to conclude on the subject.

3.4.1 Exploratory Research

In exploratory research, the design is used to bring out the general nature of the subject matter at hand, possible alternatives of the decision and the important variables that would be considered” (Kumar, 2000). This means, exploratory research is the most appropriate research which can be used to identify problems and also to define and test the possible direction of action. The flexibility and

versatility of exploratory research is very high which makes it possible for it to be used in areas of formulating hypothesis in respect of problems and opportunities that can occur. In this type of research, researchers normally have a little knowledge about the subject matter at hand should be able to adjust to any issue that might arise later on in the course of the study so that the best can be achieved out of the research. Taking this particular type of research into consideration, it cannot be relied upon like the descriptive type because, researchers who depend on it normally aim at looking for quick solutions to problems that confront organizations and institutions but it is very economical because it does not consume too much time and money. (Kumar, 2000). Exploratory research is normally used to answer questions with adverbs like when, what, when, who, where, how and other questions which combine any of these. The materials or the things that one need to have at hand before conducting an exploratory research are as follows, structured interviews, document analysis, field research, etc. (Shields, 1998).

3.4.2 Descriptive Research

Descriptive research is the type of research that takes into account the need for accurate information about an issue at hand. In other words, this type of research is used to describe an already existing phenomenon whether in an organization or in academics. Descriptive research can also be used to determine the rate at which certain specific events occur. Descriptive research can be used to look for similarities and differences between markets and consumer groups in an international business perspective (Kumar, 2000). The data of a Descriptive research should be in large quantities since the result is imperative so that it can effectively represent the actual population. During the research, hypothesis are designed before the actual research itself begins and then tested with the collected data on the topic. The main reason for conducting this type of research is to increase accuracy, reliability and minimize certain errors (Kumar, 2000).

3.4.3 Casual Research

Talking about casual research, it is very precise and used to identify a cause and relationship in a market. It is done by introducing some factors and then measure the effects these factors will identify, so in a nutshell it helps to establish the interrelationship between different variables and how these variables affects how decisions are made by management in an organization. This makes it possible for the researcher to identify which variables are the causes and which are the results as well as the ability to look for ‘’evidences of strong associations between the action and the end result that the action preceded the end result’’ (Kumar, 2000).

There are other types of research which includes explanatory, understanding, and predictive research (Shields, 1998).

In this particular work, we are going to work with both quantitative and qualitative types of research. Under the quantitative research, there is going to be a structured questionnaire which is answered by all stake holders concern and the qualitative research will take care of some interviews with some industry experts.

3.5 Data Analysis

Data analysis is used to reduce bias and assist the research to make fair conclusions analytically that does not allow misinterpretations (Yin 1994:103) which makes it possible for already gathered information to be changed into interpretations which are descriptive. The aim of the research and the information gathered on the research are both combined by the researcher using data analysis. The data analysis has other purposes like reduction of the information, presenting of the information, to verify and draw conclusions. The purpose of data reduction is to screen the information gathered for the materials that are relevant to the research. Data presentation is when the data that has been reduced is presented by using tables or graphs. The conclusion part is when the researcher ends his analysis of the study.

This particular project has been design just as the process described above. Structured questionnaires were delivered to individuals in the country where the

study is about (Ghana). The questionnaires were answered by all stake holders concern, be it household owners, business owners and experts in the Solar Industry. So after getting the views of all these groups of people, they were combined and analyzed by using the SPSS statistical software. The views and opinions of the various groups of respondents have been analyzed into detail in this report.

3.6 Validity and Reliability of the study

The term validity in research tells how reliable, stable and consistent the study is so that the result can be supported or confirm by another researcher (Yin, 1994:36). In most cases, the researcher must certified that when the same topic is researched upon by another researcher the results will be the same or similar. A reliability study can be done if questions like the following can be answered; will the same results be achieved when the same research is carried out at other times? The second question is, will similar observations be made by different researchers? Thirdly are the conclusions made in the research transparent? (Saunders et al, 2006).

In making sure that the research is reliable, a researcher tries to avoid bias and make sure that similar conclusions can be achieved when anytime the research is conducted again. Saunders et al (2006) identified the restrictions to the reliability of the research as: participant error, participant bias, and observer error and observer bias. The first two originated from the reactions of those being interviewed and their reactions to the results that came from them. The next two which are also the last ones can be caused by the researcher who is interviewing the people and how he/she approaches the questions that were used during the research and his/her interpretation of the result.

To make sure that this research is reliable, the work was based on different popular researchers who have authored books on solar energy in the literature review. Results of various researchers were compared and examined carefully. Specially structured questionnaires which were designed to gather information were also done according to the literature review. In the process of making the

research more valid, there should be a lot of sources of evidence which are very important. In the course of this research, information was gathered from different sources which were both internet and printed materials. I was in Ghana for one month when I personally delivered the structured questionnaires to individuals of the various stakeholder groups like household owners, business owners and some experts in the solar energy business to sort their views and opinions. Two different companies were also visited, one of them being a solar installing company with the name Atlas Business Services (ABES) and the other is a telecommunication company which is using solar energy for their cell sites on pilot basis to see its efficiency and the name of that company is Vodafone Ghana. According to one of the managers of Vodafone Ghana, the company started this project about three years ago and they have about fifty (50) cell sites across Ghana which are using solar to supply power to their equipments.

3.7 Diffusion Literature

In Africa and Ghana for that matter, the market demand for solar energy is going higher day by day. The current demand for solar energy alone in Ghana if continued will be more than the 10 percent penetration into the country by the year 2020 target of the Ghana Energy Commission (Energy Commission, 2006). The average annual diffusion of solar products in Ghana is increasing gradually, for instance solar products were imported into the country for installation in some few rural areas but presently there is a company in Ghana called Atlas Business Centre (ABES) which is into the production and installation of solar products across the country. In Ghana at the moment, the different types of renewable energy technologies are being used to compliment the national grid but more than half of them come from solar thermal applications.

In the following chapter, the effect of the driving forces and barriers to the proliferation at solar products in Ghana will be analyzed that is done to help understanding in a broader way the mechanisms that are included in diffusion for sustainable development. The process of diffusion of solar products in Ghana was based on three groups of stake holders.

- The Scientific and Technical Community.
- The Solar Energy Industry.
- Consumers/Users mainly households and few corporate institutions.

As has earlier been said, this research employs two different approaches to do the work. The first one is field research. Under this particular method, a number of specifically structured questionnaires were designed and addressed to major diffusion stake holders. The work consisted of a one month trip to Ghana with the already designed questionnaires which were distributed to all groups of stake holders. Two different companies were also visited for further interrogation on the topic, the first company visited was ABES which was already discussed in the previous paragraph and the second company was Vodafone Ghana, which is a telecommunication company to estimate how useful solar has been to their area of operation.

The second method used is desk research, which mainly consists of collecting and analyzing already existing data related to diffusion from official and other sources while emphasis were laid on describing the diffusion process.

3.7.1 What are diffusion barriers?

There are so many obstacles which are preventing the diffusion and or penetration of solar products onto the African market, of which Ghana is no exception. These obstacles, mostly called barriers, include cost effectiveness, technical barriers and market barriers such as pricing systems which are not consistent, and of which some are due to institutional problems. In addition, there are also political and regulatory barriers and also social and environmental barriers. Some of these barriers may be specific to a particular technology while others may be specific to a country or state (World bank, 1999).

3.7.2 Identification of barriers

Before a research can be carried on barriers that impede the penetration and diffusion of solar products into a particular country, the researcher has to identify the renewable energy technologies that are associated with solar products which

have potential in that country or state and also the necessary actions to be taken to overcome the barriers. The moment a technology is identified, the next step is to review existing energy strategies and plans, as well as the financial and institutional mechanisms including legal systems that are applicable to solar technology. The research can elaborate on some of the disadvantages in the policies and strategies that impede the implementations of the solar technology and also some reports and studies that are related to the existing renewable energy projects of national interest can be reviewed, including their evaluation, the reasons for their success and/or failures to help select the appropriate technologies and barriers to their diffusion.

The following can be some of the factors to be considered in a country when selecting the technology for the study of barriers.

- Adequate resource base for the renewable technology (solar);
- Available technologies and their costs;
- Commercial viability and financing (public, private and international);
- Environmental impacts and benefits;
- Socio-economic impacts including job creation;
- Coverage of both centralized and decentralized options.

To identify a suitable technology for a country is a very necessary step which involves qualitative and quantitative assessments. Consultations with the various governmental agencies, nongovernmental organizations (NGO's) and other stakeholders which are involved in the promotion of renewable energy technologies (Oliver M Jackson, 1999). The interaction with the various stakeholders is very important because apart from the literature on similar projects and the study of already existing projects, it helps the researcher to identify the barriers that impede the penetration and diffusion of solar products into that country.

Taking a closer look at the dialogue with stakeholder's shows that it is very necessary to consider stakeholders' opinions. Stakeholder in this regard may be made up of the renewable energy industry which solar energy falls under

(manufacturers of plants equipments and appliances, owners of plants), consumers, NGOs, experts, (policy makers) and professional associations. The dialogue with these groups may be carried out in the form of structured interviews and/or designed questionnaires. This procedure is very important in identifying the barriers because the thoughts of stakeholders on barriers in general can help reveal all the problems associated with the existing policies and help measures to overcome these barriers. Another way a researcher can identify diffusion barriers is to visit new project sites and have a closer look to obtain firsthand information which is very important to the identification of barriers (Gutermuth P-G, 1998).

3.7.3 Major barriers identified

This paragraph is going to talk about some major barriers that have been found to impede the penetration and diffusion of solar products into a developing country like Ghana. They are listed and explained bellow.

The first barrier identified is market failure/imperfection, Under this barrier there is no available information and awareness, lack of access to technology, there is no competition and the cost transaction is very high, there is no infrastructure in terms of marketing, there are too many requirements when it comes to investment and the energy sector itself is under too much control.

The next barrier identified was market distortions and under this barrier, issues like subsidies and taxes including trade barriers and in some cases where externalities are not considered. Under this barrier competition is affected because of the subsidies and the cost of solar products may go up due to high taxes on imports.

Economic and financial matters become the next barrier identified and under this category, access to capital becomes difficult to producers. Because of this, there is no competition and efficiency in the market due to limited number of producers. Consumers are not able to get access to credits and this can also reduce market size.

Lack of financial institutions to support renewable energy technologies and also lack of instruments are all part of the major barriers identified because they bring about the fact that products pertaining to a particular technology like solar products may be in short supply, which will at the end of the day affects competition and efficiency in the market. It is under these same institutional barriers that the lack of legal and regulatory framework can be found. The consequences include that, the producers of renewable energy may face market, economical and financial difficulties and when all these happen, they add to the difficulties encountered during the penetration and diffusion of solar products on the African market including Ghana.

Other barriers identified are technical, social, cultural and behavioral aspects. Under technical, this is where standards, codes and certification are lacking and the problems they bring about affect the product quality and their acceptability which makes the risk associated with buying and commercials including the perceptions about the technologies being in doubt. Facilities for training personnel and make them skillful to perform are all not available and the problem this can brings is that the products may not be accepted in the market which will lead to lack of competition in the sense that the few once in the market will be taken like that without any option because there are no options to choose from.

On the social, cultural and behavioral category, there is the barrier of the products facing consumer and social acceptance and this will bring about reduction in market size. What consumers may do under the behavioral aspect especially is that they may show certain attitudes towards products they are not familiar with. For example, consumers may have the perception that power from solar may not be so powerful especially in countries where the citizen are used to the use of hydro power, as in the case of Ghana.

3.8 How to overcome diffusion barriers

Technical potential cannot be attained through research and development (R&D) but the best that can be achieved with R&D is to reduce the gap between techno-economic potential and technical potential. The main goal here is to achieve or get

closer to techno-economic potential, since it is already known that the achievement of technical potential is not possible. To overcome the diffusion barriers is to find solution to some of the problems listed in the previous paragraph(s) under identification of barriers.

3.8.1 Liberalization of the energy sector

This is a very important topic comprising several measures to put the energy sector in order so that competition would be introduced into the sector and also at the same time remove all unnecessary controls. Some of the policies are creating operational modules for the production and delivery of electricity and allowing the private sector to come in for energy pricing could be a thing of the past, the usage and importation of fuel and capacity enlargement.

Measures on institutions like the establishment of regulatory independent bodies have been formed to oversee the measures to help liberalize the energy sector. The main purpose of this liberalization is to introduce efficiency in the energy sector to introduce competition in the market. The early signs of these measures may be consequential to the solar technology and the other renewable energy technologies due to additional competition but in the future, the environment of the energy market will be very healthy because of liberalization and a healthy growth among the renewable energy technologies will also be achieved (Norbert W, Painuly J, 1999)

3.8.2 Guaranteed markets

Solar energy is part of the renewable energy technologies which are not able to compete well in the energy market due to the so many barriers that are preventing penetration and diffusion. This problem can only change if suppliers of energy are made to include renewable energy into their supply mix. There are some countries that actually have some kind of legislation to that effect and these countries are the United Kingdom which has the Non Fossil Fuel Obligation (NFFO), The United States that has the Renewable Portfolio Standard (RPS) and Germany also

has in place the Electricity Feed Law. All these laws make it possible that some priority is given to energy from a renewable source (IEA, 1998).

3.8.3 Financial support

Governments of many countries support their citizens with financial incentives for the installations of any of the renewable energy technologies including solar energy. This is done in such a way that efficiency will increase in the renewable energy sector but any incentive introduced must have a time limit for it to phase out so that efficiency would be maintained in the sector. Renewable energy programs which are based on incentives are being operated in many developing countries and the World Bank is financing most of these programs.

One of these programs which are being sponsored by the World Bank are the Home Solar Project in Indonesia and Sri Lanka. The UNDP is also sponsoring a program in Africa called ESMAP (Piscitello ES, Bogach VS, 1997).

3.8.4 Government investments

In most countries, it is the government which is in-charge of generation and distribution of energy and as such they are the major players in the industry. Governments are responsible for drawing up national plans and strategies for the promotion of solar and other renewable energy technologies. The governments have also other special agencies through which funds are made available for the promotion of solar and the other renewable energy technologies, for example in Ghana there is Energy Commission (Energy Commission, Ghana 2006).

3.8.5 Publicity campaigns

The lack of information about solar technology in some developing countries in Africa including Ghana has made it difficult for the stakeholders to know the real value of the solar technology so Ghana has initiated informative programs through the energy commission to promote the solar technology as the government is the major player in the sector. The main idea behind this is for stakeholders to be educated and given the necessary tools so that they can evaluate the solar and

other technologies and design implementation. The campaigns are made to target promotion of a specific product (Energy Commission, Ghana 2006).

3.8.6 Research and development (R&D)

High cost has been a major barrier to the penetration and diffusion of solar products and other renewable energy technologies. Therefore, R&D programs have to be undertaken to make products more competitive. The cost of products over the years can be reduced through research (Johansson TB, Kelly H, 1993).

4.0 EMPIRICAL STUDY AND FINDINGS

Under the empirical study all the findings of the research, the results and the conclusions are analyzed. The researcher saw the need to combine both qualitative and quantitative research methods to get the results but the qualitative method was dominant during the study. This is where specially structured questionnaires were delivered to individuals who are considered to be stakeholders of the solar industry. Meanwhile, the quantitative research method was used as a supporting tool during the research.

4.1 Quantitative (Exploratory) Research Analysis

4.1.1 Atlas Business and Energy Systems (ABES)

Atlas business centre is a solar business company based in Ghana and their main area of operation is the manufacturing and installation of solar panels. The company was established in 2009 and since then the publicity about the diffusion and penetration of solar products in Ghana has been increasing very much increasing.

4.1.2 Quantitative research analysis

A total of one hundred (100) questionnaires were distributed to all stakeholders who were made up of individual household owners, business owners and experts in the solar industry all in Ghana.

Out of the hundred questionnaires distributed, seventy of them were responded to and out of the seventy questionnaires which were responded to, about 97% of the respondents are interested in the installation of solar panels in their homes for the purpose of lighting in their individual homes to supplement the national grid.

After putting all the responses together, statistical software (SPSS) was used to analyze the data obtained.

4.1.3 A. Diffusion barriers

In this section, the barriers for the diffusion of solar energy in Ghana are analyzed. After using the SPSS software to analyze the questionnaires it shows clearly that, among the diffusion barriers, lack of knowledge is the major barrier followed by cost, and maintenance (see Table 1). Lack of knowledge is the highest barrier with a mean of 5.84, and the lowest barrier is aesthetics with a mean of 3.82, as shown in Table 1.

Table 1. Diffusion Barriers

Diffusion Barriers	No. of Respondents	Minimum	Maximum	Mean	Std. Deviation
1. Cost	70	1	7	5,83	1,633
2. Not Owing a house	68	1	7	4,40	2,096

3. Other Priorities	70	1	7	4,39	1,883
4. Payback Period	69	1	7	4,83	2,051
5. Installation	68	1	7	4,24	2,207
6. Maintenance	68	1	7	5,01	1,974
7. Opinions of Friends	69	1	7	3,86	2,053
8. Aesthetics	68	1	7	3,82	1,892
9. Lack of Knowledge	70	1	7	5,84	1,742
10. Others	64	1	7	4,17	1,972
Valid N (list wise)	60				

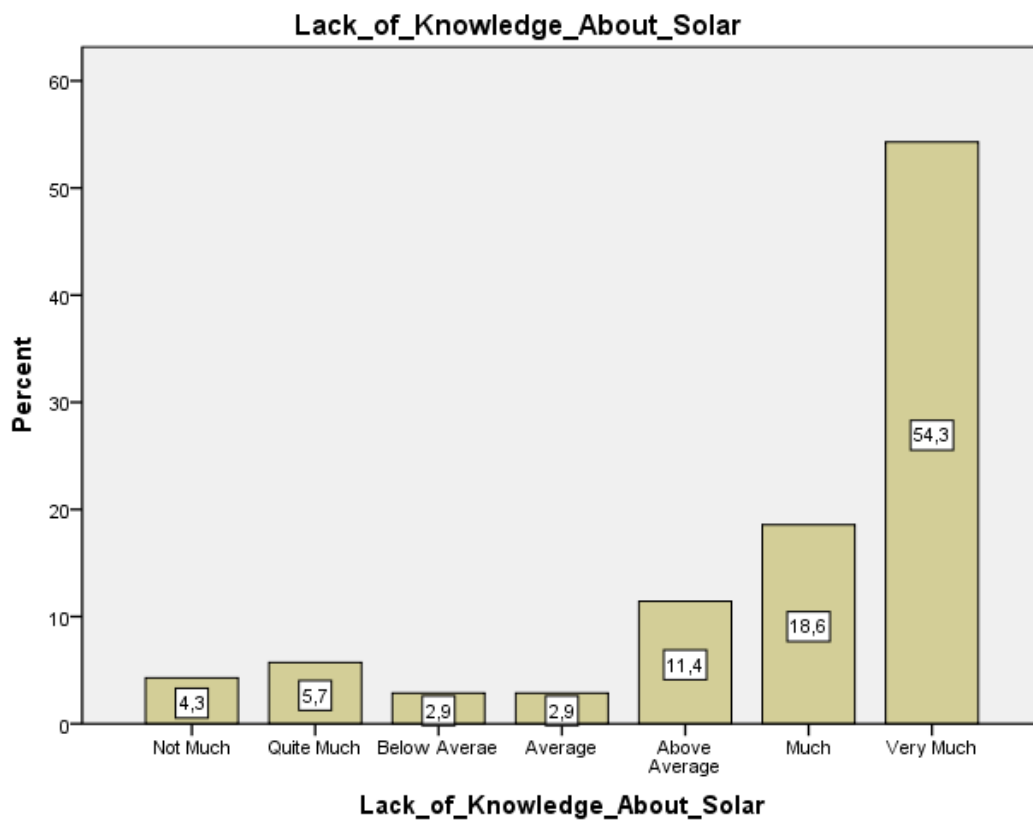


Figure 2

The graph in (Fig. 2) depicts the assertion that lack of information is the major barrier which is preventing the penetration and diffusion of solar products in

Ghana and that is followed by the cost of installation of the package, which has also been another headache to stakeholders.

4.1.4 B. Growth of solar business

In this section, the growth of solar energy business was analyzed and how important it is in Africa and the rate at which the climate is fast changing due to global warming. Table 2 shows how the respondents reacted to the various questions about the growth of solar business in Africa. Even though Africa has a very high potential of natural sunlight the continent has been very slow in adapting to solar power as an alternative energy source.

Research and Technology was the highest item with a mean of 5.63 followed by Available Income and Public Awareness with a mean of 5.47 each. This means that there should be more research into the technology and also public awareness must be intensified.

Table 2. Growth of solar business

Growth of Solar	No.	Minimum	Maximum	Mean	Std. Deviation
1. Available Income.	70	1	7	5,47	1,917
2. Public Awareness	70	1	7	5,47	1,657
3. Incentives (loans)	69	1	7	5,29	1,872
4. Research & Technology	70	1	7	5,63	1,652
5. Solar Industry.	70	1	7	4,94	2,014
6. Promotional campaign.	70	1	7	5,09	1,909
Valid N (list wise)	69				

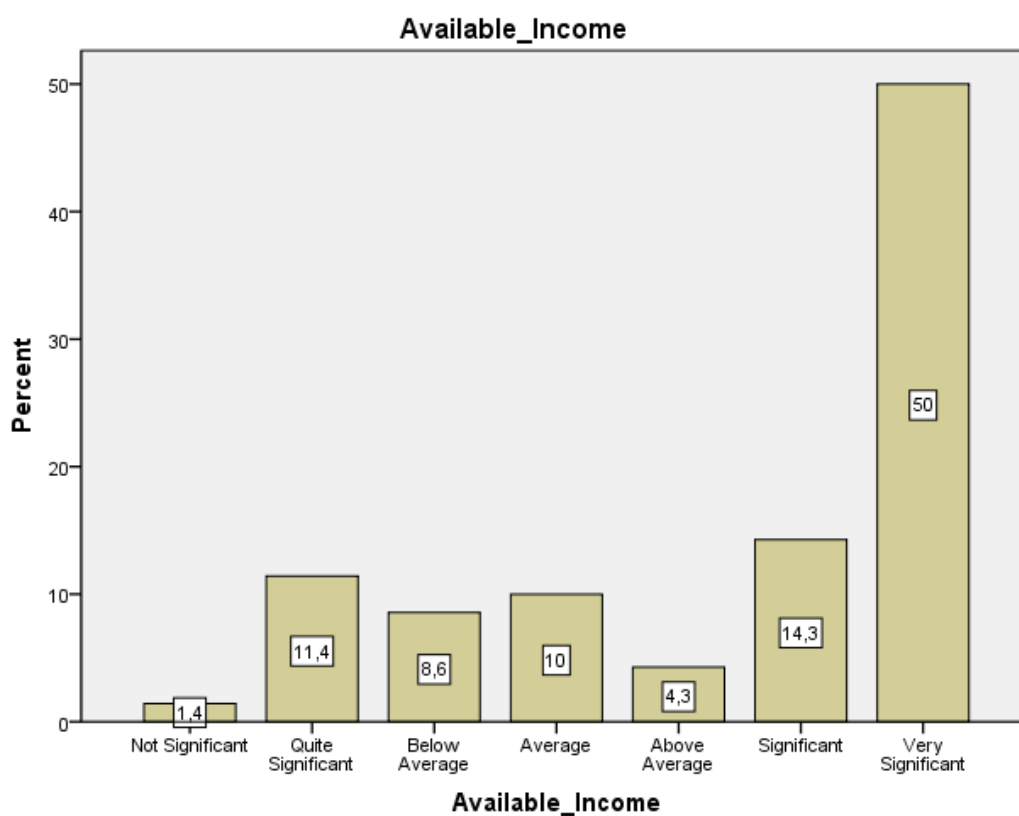


Figure 3. Available Income

(Fig.3) shows how people believe that having access to income is one of the barriers that retard the growth of solar business in Ghana.

4.1.5 C. Driving force

Driving force is referred to as the things that prompt people to choose solar power as an alternative energy source in Ghana. They are the things that will make people think of getting a solar package as an alternative source of energy in their homes or wherever they will need energy. Under the driving force, a number of things were considered including solving energy problems, social prestige, protection of the environment and others.

After analyzing the questionnaires that were answered by the respondents, it was revealed that the main reason that drives people to install a solar package is to solve energy problems with a mean of 5.78 as shown in Table 3 and followed by environmental protection reasons with a mean of 5.71. That means that people

want to use energy that is environmentally friendly so that the emission of greenhouse gases into the atmosphere will reduce. The table below describes the statistics of the analysis.

Table 3. Driving force

Driving force	No.	Minimum	Maximum	Mean	Std. Deviation
1. Reduction of hot water cost	66	1	7	3,36	2,331
2. Hot water all 24hrs	66	1	7	2,89	2,149
3. Solving energy problems	69	1	7	5,78	1,513
4. Short payback period	67	1	7	4,01	1,895
5. Protection of the environment	69	1	7	5,71	1,750
6. Less dependent on oil	70	1	7	5,47	1,800
7. Opinions of friends	69	1	7	4,14	1,920
8. Promotion campaign	70	1	7	5,20	1,716
9. Less taxable income	69	1	7	5,26	1,738
10. Social prestige	69	1	7	4,94	1,970
11. High electricity cost	70	1	7	5,04	2,216
Valid N (list wise)	61				

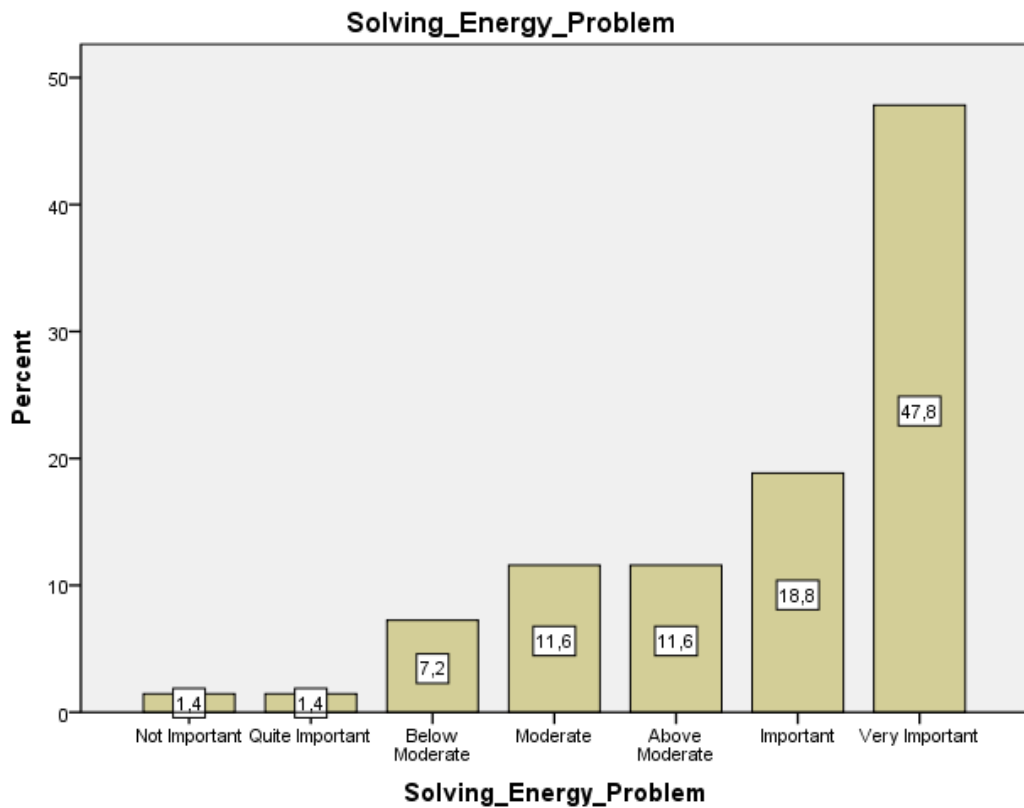


Figure 4. Solving Energy Problems

Figure 5 also represents the portion of the respondents who think people go in for the solar package to solve their energy problems.

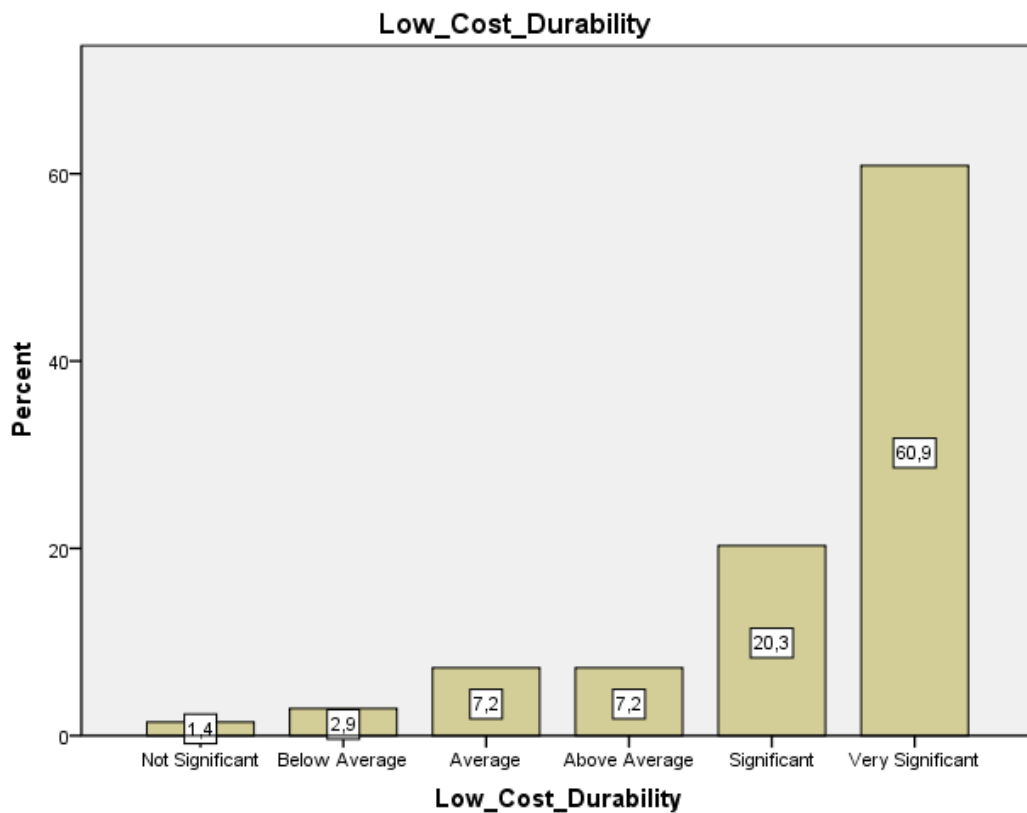
3.8.4 D. Brand names

The selection of a solar product can be determined by certain significant indicators which include cost, image of manufacturer and others.

The Chart bellow shows how all the various items under brand names and how they were reacted to by the respondents during the research. The respondents think that low cost/durability with a mean of 6.23 is the first thing to be taken into account when choosing or selecting a solar product. After that the next thing one should think about when selecting a solar product is the quality of the materials that were used to manufacture the products. That item also had a mean of 6.12.

Table 4. Brand Names

Brand names	No.	Minimum	Maximum	Mean	Std. Deviation
1. Low cost/durability	69	1	7	6,23	1,250
2. Quality of materials	69	1	7	6,12	1,409
3. Guarantee-maintenance	69	1	7	6,07	1,354
4. Persuasio by sales person	69	1	7	4,61	1,880
5. Easy installation	69	1	7	5,45	1,819
6. Image of manufacturer	69	1	7	4,72	1,901
Valid N (listwise)	69				

**Figure 5. Low Cost/durability**

The Fig. 6 above shows the views and opinions of the various respondents about the selection of a solar brand. During the research 60.9% of the respondents

believe that low cost/durability should be considered first when one selecting a solar brand.

4.1.7 E. Individual shareholder's perspective

The individual shareholders are all various groups of people who are concerned with the growth of solar energy and will do anything possible to promote its success because they are in one way or the other benefiting from the existence of the technology. Some of these stakeholders are individual household owners who need solar power in their homes for domestic purposes and also business owners who need the technology as an alternative energy source for the operation of their businesses. During the survey, the views of four different groups of people were sought and the majority of these people belong to the household group.

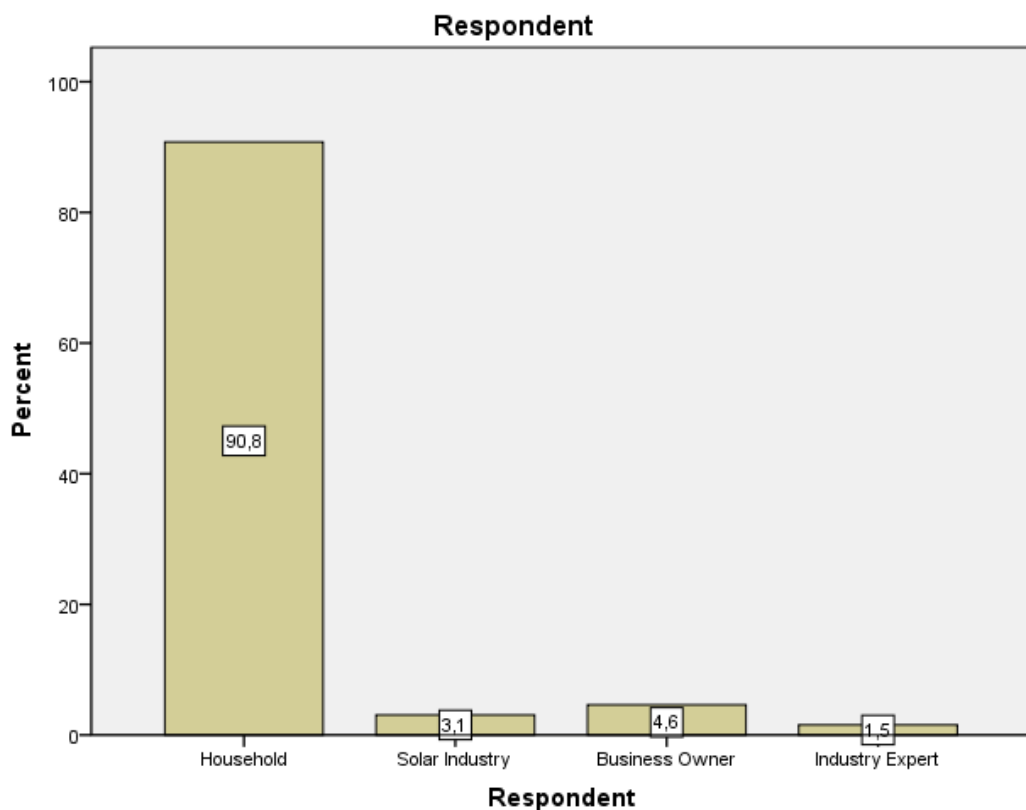


Figure 6. Various Stakeholders

Fig. 7 shows the category in which the individual stakeholders belonged to. Over 90% of the people belong to the household category. This means that many people

in Ghana are looking for solar power as an alternative energy for household purposes.

3.9 Industry type

During the survey, respondents were asked which type of industry they will need the technology to work within. The two main types of industries considered were the manufacturing and the service industry. The majority of the respondents say they will need solar technology for the service industry.

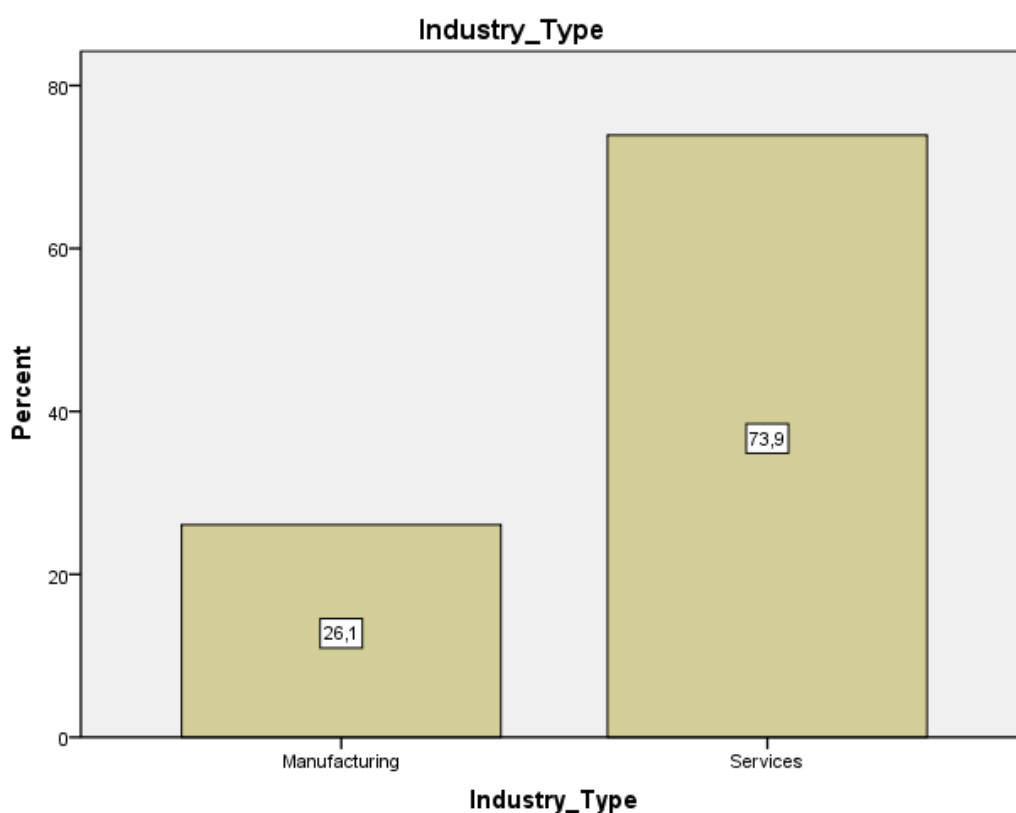


Figure 7. Industry Type

The graph (Fig. 8) above shows how respondents answered the questionnaires and shows where they belong and the technology will be needed for. 73.9% of the respondents belong to the service industry while 26.1% of them belong to the manufacturing industry.

3.10 Likelihood of installation

The issue about the likelihood of installation came at a point during the survey when the question about installation was put before the respondents to study the future of solar energy in Africa and Ghana. It was the time when majority of all stakeholders being our respondents revealed to us that they would like to install a solar package someday in the future. This means there is a potentially huge market for the solar energy technology in Africa and Ghana.

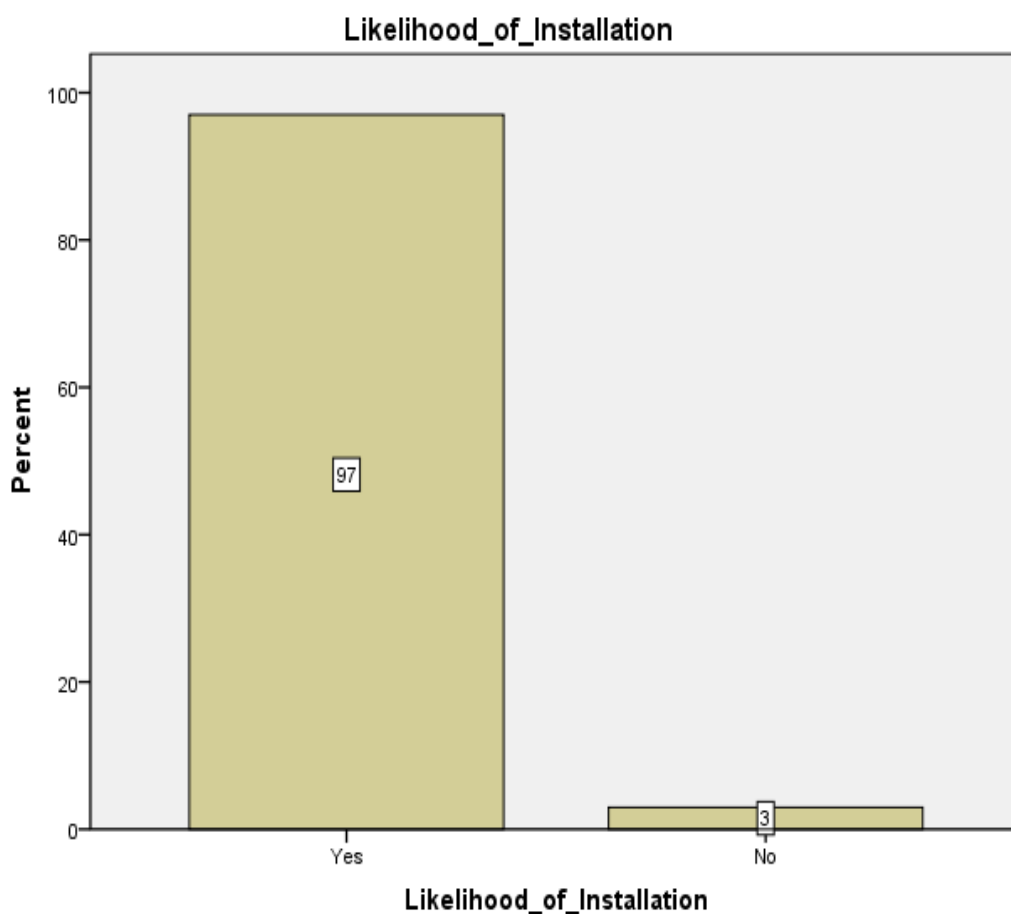


Figure 8. Likelihood of Installation

Fig. 9 above depicts the assertion that majority of the Ghanaian population are interested in the installation of solar energy as an alternative energy source. 97% of the respondents expressed that they would like to install the solar package as an alternative energy source in the near future.

5.0 ANALYSIS OF THE STUDY

5.1 Diffusion Barriers

The analysis on diffusion barrier shows that lack of knowledge; cost and maintenance were the highest diffusion barriers. This indicates that there is the need for more education and training programs to create awareness in the benefit of solar energy in Ghana.

The least barrier is aesthetics; this implies that the sight of solar panels on the roofs of consumers is not a problem in Ghana, as it might be the case of other countries.

5.2 Growth of Solar Business

The growth solar power in Africa as whole has been a major concern to some individuals who are interested in the technology and how it works so that the issues about energy problems would become a thing of the past. During the study, the analysis on the growth of solar business in Ghana shows that research & technology were the highest on the list and followed by available income and public awareness on energy savings. This implies that research should be intensified on solar to improve upon the technology and make it well known to every household. The analysis on the growth of solar power also revealed that there is the need for public awareness on energy savings for every individual to know what goes into waste of energy and the long term effect.

5.3 Driving Forces

The analysis on the driving forces indicate that almost all the people who install solar packages in their homes do so to solve energy problems because it was the highest on the list followed by protection of the environment. This implies that even as people want to solve their energy problems they would also like to protect the environment from harmful substances that pollute the air we breathe and causes sickness and diseases. Another effect of not using an environmentally friendly type of energy is that it increases the emission of greenhouse gases into

the atmosphere and contribute to the depletion of the ozone layer which long term effect is the increased global warming.

5.4 Brand Names

In this section, the analysis on brand names suggests that among all the items that were considered, low cost/durability was the highest followed by quality of materials and then guarantee-maintenance. This means that house owners who would like to install solar power equipment will look for products which are very durable but moderate in terms of price but even as people are looking for moderate products, they will still be thinking about the quality of the materials used. Guarantee-maintenance also implies that home owners will be going in for products with the assurance that maintenance after installation is assured. The lowest on the table of analysis was persuasion by sales persons which implies that persuasion by sales persons will not have much influence on home owners who would like to install a solar package.

6.0 CONCLUSION AND RECOMMENDATIONS

Solar energy technology is one of the most cost-competitive forms of technology with conversional sources of energy with so many applications, but even with that its full potentials has not been tapped yet. In emerging countries where the access to energy is not possible for a large population who have to provide potentials for the growth of solar energy technology even if developing countries succeed in tapping a fraction of the potential market for solar energy.

In some industrialized countries efforts are being made to increase the share of solar power and other renewable energy technologies because of the considerations for environmental and sustainability issues in the use of energy. According to the research leading to the conclusion of this paper, solar energy has a very huge market in Africa and Ghana.

However, there are so many barriers which are in different forms across countries that impede the penetration and diffusion of solar products and that of other renewable energy products. These barriers need to be identified and be done away

with before this goal can be achieved. A framework of this purpose has been proposed in this research.

The identification of barriers started with the explanation of what is meant by diffusion barriers for the study of major barriers identified through the literature review on solar energy and related projects in Ghana. The study of the major barriers and the things to do to overcome them should be carried out using the literature review, site visitations and interaction with the various stake holders. In this case, the stakeholders include household owners, business owners, industry experts, manufacturers of equipment and appliances and all other consumers including NGO's, policy makers for the government and professional associations. The opinions and views of stakeholders can be obtained through a designed questionnaire or a well structured interview. It is very necessary that all barriers are discussed and their effects revealed during the interaction with the various stakeholders. The major barriers such as market barriers, economic and financial barriers, institutional barriers and technical barriers have several elements which are the causes of those barriers. The effects of these barriers vary across countries as well as their solutions that are the steps to overcome them. The responses from stakeholders should be able to help identify the barrier and the stakeholders' views on the measures to overcome should also be available afterwards.

With regards to the research question under likelihood of installation, it was revealed that the majority of the respondents are interested in installing a solar package someday. This shows that the market possibility of the solar energy in Ghana is very high. Since Ghana has a lot of things in common with her neighboring countries, the situations in those countries might possibly be the same as in Ghana in terms of the interest the people have shown in the technology. The energy situation in Ghana is far better than that of her neighboring countries, so if Ghana has 97% of the total respondents showing interest in the installation of solar power as an alternative energy source then those countries which have a worse energy situation will possibly show even more interest.

Suggestions for further research

The study of the solar energy technology as a source of renewable energy is very broad when all of its aspects are considered. This study focused on the barriers that impede/prevent the penetration and diffusion of the products that constitute a solar package in Ghana and other African countries. However, it is recommended that further studies on market possibilities and financial benefits of solar energy in Ghana must be done.

As a result, the whole publicity about the technology would be available to the general public which will attract private participation into the production and distribution of energy in Ghana as a country so that the Millennium Development Goals (MDG) can be achieved.

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APPENDIX

Research Questions

A. Diffusion barriers

Please indicate the extent to which of the following are significant barriers to obtaining a solar product.

1= Not much**7= Very much**

(a) high cost						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(b) not owning the house						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(c) other priorities						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(d) high payback period						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(e) difficulty of installation						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(f) high maintenance cost						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(g) opinions of friends						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7

(h) aesthetics						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(i) lack of knowledge about solar						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(j) others						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7

3.11 Growth of Solar Business

Please indicate the extent to which of the following has a significant impact in explaining the growth of business in Ghana.

1= Not Significant

7= Very Significant

(a) available income						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(b) public awareness on energy saving						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(c) incentives (loans)						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(d) research and technology						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(e) solar industry						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(f) promotional campaign						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7

4 C. DRIVING FORCE

Please indicate the extent to which of the following are important forces driving the diffusion of solar business in Ghana

1= Not important

7= Very important

(a) reduction of hot water cost						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(b) hot water all 24hours						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(c) solving energy problem						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(d) short payback period						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(e) protection of the environment						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(f) less dependence on oil						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7

(g) opinions of friends						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(h) promotion campaign						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(i) less taxable income						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(j) social prestige						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(k) high electricity cost						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7

4.1.1 D. Brand Names

Please indicate the extent to which of the following have significant impacts in selecting a solar brand

1= Not Significant

7= Very Significant

(a) low cost/durability						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(b) quality of materials						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(c) guarantee-maintenance						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(d) persuasion by sales person						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(e) easy installation						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7
(f) image of manufacturer						
<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5	<input type="checkbox"/> 6	<input type="checkbox"/> 7

2. Please indicate which of the following applies to you:

**Household ___ Solar Industry ___ Business owner _____ Industry expert's
_____**

3. Please indicate the likely area of use of solar energy

Light _____ Hot Water production _____ Other _____

4. If you are a business owner, please indicate which industry you belong:

Manufacturing ___ Services _____

5. Name any solar brand you are familiar with in Ghana: _____

ACRONYMS

ABES- Atlas Business Energy Services

MDG- Millennium Development Goal

NGO'S- Non-Governmental Organizations

IEA- International Energy Agency

CIDA- Canadian Development Agency

