**Topic:**

**THE ENERGY SECTOR IN CAMEROON: Contribution of Solar Energy in Energy Sustainability in Northern Cameroon.**

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# Abstract

Over the past decades, access to energy sources has been a major concern to both developed and developing economies. Sufficient energy supply has been identified as an important factor in industrial development as well as in increasing the wellbeing of people. This thesis examines the energy sector in Cameroon and presents a general overview of the county’s energy capacity. The study reveals that despite being endowed with abundant energy resources, Cameroon suffers from insufficient energy supply. After presenting the general energy situation in the country, this thesis undertakes a detail study of the possibility of using solar energy as an alternative and clean energy source in the northern part of Cameroon which happens to benefit from the advantage of having sun light abundantly all year round, but which unfortunately is the least energy consumer in the country. The northern part of Cameroon is used as a case study in this thesis. This thesis then rounds up with a discussion of the economic, political and institutional challenges and obstacles to the industrial exploitation of solar energy in northern Cameroon.

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**Introduction**

From the time of the early men to present, energy has been one of the most important elements of every single civilization especially the modern one. All societies depend on one of the different energy sources for its very survival. Energy is one of the basic essentials for livelihood and development. Energy has transformed societies, by changing the way we live our everyday lives, has created political conflicts, and have engendered new research. According to the International Energy Agency, (IEA, 2005) about some 1.6 billion people around the world have no access to electricity or other modern forms of energy. Developing countries especially Sub-Saharan Africa and South Asia have the highest number of people with no access to energy. With over 80 percent of the rural population concerned, access is still very limited, even though the energy sources are available.

Since most of these countries are developing economies; their populations very much depend on energy for growth. Cameroon is one of such countries that have experienced a continuous energy crises since the year 2000.This has been because of a number of reasons; such as depleting oil petroleum resources, climate related problems like drought and the desertification of some parts of Northern Cameroon, high demand for electricity for household as well as industrial consumption. Because of the ever increasing demand for energy and the energy sector being unable to satisfy the needs of the population, regular electric power shortages, shortages in liquid petroleum gas, have been frequently registered. Also a steady decline in oil production has led to high fuel prices.

Energy like we all know is very much connected with all sectors of the society and any disruption in one sector could mean having a negative impact on the socio-economic development of a country as a whole. On the other hand, new tailored research and development of other energy sources will mean increase of energy supply. Energy trends around the world have shown that there is much dependence on oil and natural gas for energy (Pedersen, 2010). Unfortunately, these energy sources are finite fossil fuels, thus there is the possibility that someday, these resources will eventually deplete (Pedersen: 2010). Therefore, if alternative measures are not put in place to guarantee the energy needs for the future, then there is a risk of energy insufficiency, and so the over-dependence of the world’s energy supplies on these finite resources will become unsustainable.

The need for energy security in developing countries cannot be undermined because it is a resource that connects all of the society. There exist a tight relationship between energy and poverty in a developing economy like Cameroon. Statistics have been collected to prove this connection, and of late, the United Nations undertook some measures to improve on the energy situation in some countries by linking their development plans with the development of the energy sector. These initiatives were embodied in most poverty reduction strategies papers (PRSP) prepared by individual countries to that effect ( see for example Cameroon’s PRSP,2009).According to the United Nations, more than two billion of the six billion population in the world live below the poverty line; that is to say, they are considered to live on an equivalent of less than $2 a day PPE (purchasing power equivalent).In support of this, some research have shown that energy is key in achieving the Millennium Development Goals, either through the reduction of extreme poverty and hunger, achieving universal primary education, reducing child mortality, improve maternal health, ensuring a healthy environment or to fight endemic diseases (HIV / AIDS, Malaria).For these world’s poor population, finding energy sources for cooking of food or heating is a major problem. Food remains a basic element for livelihood, thus many people in rural areas depend on energy in stimulating their agricultural productivity and in maintaining their household’s access to healthy food. Already, there are predictions that by 2030, there will be global food insecurity. According to Barbara Stocking, Oxfam's chief executive, “increasingly pressing challenges of climate change, spiralling food prices and the scarcity of land, water and energy,” will increase the price of key crops by over 120 percent by 2030 if alternative measures are not put in place now (BBC, 2011). Such measure will include possibly putting in place new sustainable energy sources. As of now, demand for energy for household consumption has caused many women and children mainly in the rural parts of Cameroon to spend long hours searching for fuel wood for their energy needs (World Bank: Country Profile: Cameroon, 2010). This has been identified as a problem both for the women and children, because the long hours spent scavenging for energy resources would have been put to better use, which would have been time saving for both. The nexus between energy, poverty and gender in developing countries like Cameroon has been under discussions in different areas, and many advocate have emphasised on the point that energy is important not only to industrialised and urban areas but also to the rural population who are mostly dominated by women and children. Its importance to women is primordial to sustainable development as:

“Without access to efficient and affordable energy sources, they have very limited opportunities for economic and social advancement. Expanded energy sources are needed in rural areas to provide: mechanical power for agriculture, food processing, water pumping and irrigation; modern fuels for cooking and heating; and electricity for lighting, refrigeration, communications, commercial enterprises and community services” (FAO, 2006)

Therefore, access to energy supply and development of new energy resources is vital, for without it, if the rural population continuously depend on biomass (fuel wood), they will leave immeasurable depletion of the environment, damage their own health, and create an energy and environmental insecurity for the future generations. These arguments led to the recognition that there is a linkage between energy, poverty, gender, health and the environment. The United Nations and the World Bank sought to address the issue of energy poverty through various mechanisms, amongst which was the dedication of some of their resources towards renewable energy development. To get out from poverty and ensure sustainable development, there should be a considerable availability of energy to boost local businesses, ensure transportation of goods to the markets, and provide clinics with lighting and other basic needs (Jefferson, 2005).

 With this in mind, Cameroon as a developing country has been challenged with the problem of energy supply for many decades now. But during the last decade, the situation has been more difficult as concerns all the energy resources in Cameroon. Oil and petroleum which is Cameroon’s main export has witnessed a drop in production from 1116000 barrel a day to only 85.000 barrel a day. A projection into the future has shown that by the 2030s, if other oil fields were not identified, then Cameroon will be heavily dependent on imported oil. Even though Cameroon is an oil exporter, she still depends on 90 percent of imported oil from neighbouring Nigeria for local consumption (Nkue et al, 2009). This will exacerbate the current problem of energy crises and will mean higher prices for household consumable gas. In terms of access to electricity, the energy demand remains unsatisfied and the rate of access to modern energy is very low, around 15% for electricity and 18% for domestic gas in national averages, and in addition, access to electricity is less than 5% in rural areas against 50% in urban areas (AES Sonel, 2006; Nkue et al. 2009). With the high demand for electricity in most rural areas, and the sector’s inability to meet these demands, this research is set out to question whether the energy sector (electricity) in Cameroon is capable of guaranteeing energy security for the future? And without energy sufficiency, can the rural population come out of poverty considering that they need electricity to improve their socio-economic condition?

Despite the fact that most Cameroonians have limited or no access to modern forms of energy such as electricity and consumable fuel, it is paradoxical to know that Cameroon like many other African countries has a huge potential of untapped renewable resources such as hydro, solar and biomass. In fact, Cameroon has the second highest hydro potential in Africa after the Democratic Republic of Congo, but until date, just above 3 percent of these potentials has been put to use (Ministry of Energy, Mines and Power, 2000). Out of the above 3 percent of the hydro potentials in place, since the year 2007, low rain falls and constant droughts has led to intermittent power cuts across the national territory, which once more lead us to question how sustainable the hydro electric dams could secure energy in the midst of climatic variations? In the meantime, the electricity company in a bit to increase power production set up a thermal plant called Limbe (AES SONEL, 2006), while embarking on the construction of another hydro-dam. But these efforts still fall short of the expectations and electricity demands of the population whose energy needs cannot be fully satisfied alongside those of heavy energy consuming industries like ALUCAM (Ngala, 2009). Critics of the government believed that investing in other sources of energy such as Solar would be a welcome relief.

Solar energy is one of the energy sectors that has been poorly developed across the Africa continent as a whole and Cameroon in particular. Despite the abundance of sunshine especially in Northern Cameroon which is arid and dry receiving sunshine regularly throughout the year; the drop in the water level of the Lagdo dam has not made the government to think that developing the solar energy sector in this region could be a way of using its resources and addressing the problem. Looking at the problem of energy in country as a whole, the question one would ask is: given Cameroon’s energy crises and its huge untapped renewable energy resources, can the processing of solar energy in Northern Cameroon be part of a solution to Cameroon energy crises and a drive for sustainable energy development? This consideration will lead the main research question for this thesis.

**Objective of the Study**

The main objective of this thesis is to explain and develop an understanding of how electricity generated from renewable energy resources can contribute to sustainable energy development for countries with huge potentials such as Cameroon. Using solar energy as an example, the study thus seeks to assess the possibilities and constraints that will be involved in realising this untapped resource. By using examples of solar projects in other countries, this study will show how solar energy can be beneficiary to Cameroon.

The specific objectives are:

1. Assess the solar energy initiative and its suitability in Northern Cameroon.
2. Examine the role and participation of various actors in the solar project.

To realise these objectives, an understanding of the historical overview of the energy sector in Cameroon has been undertaken as part of an effort to identify the main problem affecting the energy sector in Cameroon, and as part of the solution to enable us find adequate answers for the problem statement and subsidiary research questions.

**Problem Statement**

For the last decade, Cameroon has experienced a continuous energy crisis as a result of insufficient production capacity and increasing demand for electricity. This growing demand for electricity in Cameroon has been linked to the desire of the population to improve on their living conditions. Unfortunately, since the year 1998 these demands have not been attained, due to the constant rationing of electricity supplies most especially between the months of January and June when there is low rainfall. For Cameroon to achieve a certain level of development, it must boost up the energy sector. As noted by the Minister of water and energy in May 2009: “I can’t imagine Cameroon evolving into an emerging country by 2035 as planned, without (an) adequate energy supply.” (Luc Bernard Sindeu, 2009)
 To meet these growing energy needs, many investments associated with an adequate energy policy is necessary to build new production facilities for the improvement and expansion of transmission and distribution (Tchouate, 2003). Faced with economic hardship and buried in external debt since the late 1980s, it became difficult to secure new finances for investment in the energy sector (Nzene,2005). This situation is further compounded by outdated power production facilities and power grid in recent years, leading to power rationing between 7pm till 8am during the months of January to June. For Cameroon to move towards sustainable energy development, it must therefore ensure that the rural population has access to electrification. Such could be realised through solar energy. Even though Cameroon like other African countries faces the same problem of energy crises, in Kenya for example, presently above 4percent of rural household have access to electricity from solar (Kalyegira and Gant, 2010).

Nevertheless, in 2002, Cameroon in an effort to revived the electricity sector and increase production, privatized the state own company (SONEL).But this privatization scheme has not resolved the energy needs of the population, neither has it decentralised production. Apart from some two mobile Companies MTN and ORANGE Cameroon who have started using solar panel to replace some of their diesel generators that supplied power, the use of solar energy in the country still remains extremely low and unaccounted for. So the fundamental question this thesis sought to address is:

 Why is there a limited use of Solar Energy in Cameroon amidst the energy shortages in many parts of the country, despite the abundance of solar radiation in the country?

In order to find answers to the above problem, the thesis will equally examine the following questions:

How does a country like Cameroon endowed with enormous natural resources integrate alternative energy sources to generate electricity through solar panels in the country as a whole and Northern Cameroon in particular?

What are the challenges and obstacles solar energy will face in production, distribution and maintenance in Cameroon, and how would solar energy generation benefit the poor and the environment?

**Methodology**

In deciding how to research a phenomenon, a development student, like any social scientist, is confronted with a large number of possible research strategies and methods. In practice, a combination of methods may be used. In this thesis, in order to gain familiarity with the current thinking and best practice concepts within the renewable energy sector, the method adopted was the analytical approach. Using this approach implies that the thesis will entirely rely on secondary sources. The secondary data employed in this research can be roughly grouped according to the following broad categories. First, there is technical literature consisting of published scientific papers or volumes concerning theories applicable to the research topic and theoretical studies of the methods employed in the social sciences. Second, unpublished documents but still relevant literature were made available by local press, research centers, national institutions (government ministries), intergovernmental institutions such as the World Bank, UNDP, UNEP, FAO, IEA.,I made a good review of a comprehensive available literature. Finally, there was the extensive use of electronic materials that was downloaded in different websites on the internet on statistics of Cameroon’s energy sector from as early as 1980s to present. The combination of these methods gave me the strong grounds on which to come out with the results of this research. I made use of my bilingualism to exploit French related documentations, some with very vital contents which were not available in English to give this study a good taste.

Through these varied sources of information, I gained further understanding of the experiences gathered in the implementation of solar projects for rural electrifications in countries around the world. This method also enabled me to analyze, evaluate, understand and discuss the different concepts which have been brought forth by other authors as unambiguously as possible. In this way, one could then construct his own ideas and use different sources of evidence to support them. One of the reasons for choosing this approach was because, it enable one to collect much information without displacement. So I could easily analyse specific information that is relevant to the realisation of this thesis.

Although the use of research method in describing and explaining or solving essential problems would have been an ultimate step forward, the consideration taken into account in this research was the case study research. For in-depth analyses, this thesis made use of the case study methodology. The discussion will be on Cameroon’s energy sector. But due to time constraints, we have limited discussions on the electricity sector. The Northern region of the Country was chosen as the case to be analyzed how solar energy can be maximized there. Northern Cameroon is a general description of three regions namely: North, Extreme North and Adamawa. The justification of the case of Northern Cameroon in this research is based on a number of factors: firstly Northern Cameroon is more arid and dry, has a regular sunshine of seven to eight months a year with sunshine hours sometimes averaging ten hours a day(Abeh,2003). Temperature averages between 18 and 45 degrees Celsius. Solar radiation received in this area is 5.8 kWh / d / sq m on average 42% of diffuse radiation (Njomo, 1988).The region has only one major hydro-dam (Lagdo dam) which generates insufficient electricity (due to constant drought) for the Northern Grid. Besides the Northern region especially the Extreme north region is classified as the poorest region in the country. In addition the region as a whole is experiencing a high level of desertification process due to continuous sunshine over the years. Finally, the region suffers from low agricultural productivity because of these climate related factors and lack of power to generate large irrigation schemes to foster high productivity. Because of these factors, this region just like other regions in the country has been unable to move a majority of its population out of extreme poverty and hunger, and the need for household energy has contributed greatly to the environmental degradation of the region since a great majority of the population there like the rest of Cameroon’s rural and urban population depend on fuel wood.

So the choice of Northern Cameroon is significant for this thesis as it would examine how the region most abundant resources could be put to better usage. Apart from this case, in the development of the thesis, two solar projects one in South Africa and the other in Ghana will be used as references to understand how the issue of product, place, price and promotion could affect the successful implementation of a future solar project in Northern Cameroon. These two examples will also provide us with invaluable information on lessons learned which can be translated into the Cameroonian context.

**Delimitation**

The cause for renewable energy is relatively a recent development on the international scene, and the recently the Japan nuclear crises furthered the call for countries to invest more in renewable energy for electricity generation, with Germany already setting a deadline of 2021 to shut down all its nuclear facilities. Though Cameroon generates most of its electricity from hydro-dam which is also a renewable source, climatic variations have also affected the water level of these dams by means of droughts. So solar energy is still a new area where Cameroon can still find her energy needs in. For the purpose of this thesis, I intend to limit the studies from the 1970s to present. The choice of this time from is because it was from the 1970s that the first ever hydro dams were completed for the generation of electricity and grid distribution in the country.

It will be important to look briefly at the different impacts these dams had on the lives of population at the time, and to also look at the changes that have occurred within the electricity sector until now. However for more confined but broader development of the theme, I will focus on a recent date the 1990s when Cameroon experienced the economic crises to present. This will permit us to look at recent issues like solar energy and climate change, energy poverty and poverty, energy and sustainable development. It is important to note that this thesis will not be looking at the existing electricity sector in Cameroon, but rather it will look at how the solar system can be developed in the country through the northern region and how it stands to benefit the rural population.

**Difficulties**

One of the greatest difficulties which I encountered during the process of writing was to rewrite the first three chapters of this work. At the end of May, there was a spyware attacked on my laptop, and unfortunately for me, I lost the first three chapters of my work, and so i had to start all over. So, I was constrained by time, trying to meet up the deadline. Besides that, in terms of data collection for the write up, it was difficult to get some documentation from the field as I would have loved, the ministry that is in charge of energy in Cameroon has had a lot of displacement from one site to the other, and archives were not in order, so I made a lot of efforts to contact the personnel to provide me with recent data. Despite these difficulties, I was still able to produce this piece.

**Chapter Layout**

The thesis is made up of six chapters. There is an introductory chapter which presents the context and frame within which the research will be centred. It briefly introduces the problem and the research questions, and the approach through which the answers to the questions will be provided. Chapter two presents the context and concepts that make up the whole piece of work. In this chapter, we identified two key concepts: energy poverty and energy sustainability. All two concepts are somehow linked together. In order to get a better understanding of the concepts, we came up with some different definitions .This chapter makes an attempt to briefly present the energy situation in Cameroon, and particularly in the northern part of the country by relating energy to poverty and looking for a possible energy solution to the future which is sustainable. Chapter three looks looks at the theory of productive power and resource curse theory. Chapter four is based on case study of North Cameroon, while chapter five looks treats the analyses based on the two theories above.Finally, the sixth chapter concludes the discussions and provides answers to whether solar energy can be processed in Northen Cameroon for sustainable energy, and equally, answers the question why the use of solar energy is limited in Cameroon despite the abundance of sunshine.

**Chapter Two**

**Definition of Key Concepts**

In this chapter, we shall be looking at two key concepts; energy poverty and energy sustainability. A Concept can sometimes be useful, as well as contradictory in a given theme depending from which angle one looks at it. It is important to note that there are different definitions to each of the two concepts, but for the purpose of this thesis, we shall adopt the ones that best describe the context under which the theme is developed. Before we get into the concepts, we should look briefly at the word energy.

**Energy**

There have been many challenges facing today’s global world, and energy has been one of them. According to the UNDP and UNIDO, if concrete actions were not taken to address the energy needs of the world population, then by 2030 it is estimated that those in need and without access to modern form of energy will surpass the present (IEA, UNDP and UNIDO 2010).Energy has a close relation with other challenges facing the world today, such as food security, education, health and climate change (Patrick, 2011) The absence of sufficiency in this chain has given birth to a new terminology called energy poverty. Before getting to the bottom, it would be necessary to define energy. Energy can be defined based on two understandings: what energy does, and what energy is. The Webster dictionary defines energy (Jefferson, 2005) as:

1*a* **:** dynamic quality <narrative *energy*> *b* **:** the capacity of acting or being active <intellectual *energy*> *c* **:** a usually positive spiritual force <the *energy* flowing through all people>

 2**:** vigorous exertion of power: effort<investing time and *energy*>

3**:** a fundamental entity of nature that is transferred between parts of a system in the production of physical change within the system and usually regarded as the capacity for doing work

4**:** usable power (as heat or electricity); *also*: the resources for producing such power.

If we were to go by the third definitions, the next question to ask ourselves will be what is this “fundamental entity of nature” referred to here? To get a concise meaning of energy and to make it more operational, (Øvergaard, 2008) notes that there should be a differentiation between the types of energy. She identifies primary and secondary energy. The United Nations considers primary energy to be

“those sources that only involve extraction or capture, with or without separation from contiguous material, cleaning or grading, before the energy embodied in that source can be converted into heat or mechanical work.”

Meanwhile secondary energy is the source of energy that results from the transformation process of primary sources (UN, 1982 Øvergaard 2008) .

 Defining energy will depend on the source and result. It is as a result of the absence of these resources, the insufficient supply of this energy, the unsustainable management of these energy resources to a given population that a region or country is considered as being energy poor.

In order to define what energy poverty is all about, it is necessary to ask, which are the sources of energy that are available? Which of them are unavailable? What determines a particular region energy poor? Is it the unavailability of energy sources, the lack of access or the under consumption of energy resources that makes them energy poor? With this in mind, one can easily define and understand what the concept of energy poverty is all about.

The distribution of primary energy resources in the world has placed some region with very high amount of primary energy resources, but unfortunately some of these regions have underutilized their resources or have been exploited of these resources. An example is crude oil which is the base for different types of petroleum products. Cameroon like other oil exporting countries have depended on the exportation of this resource to western countries in return for revenue, technological transfer and as a guarantee to secure loans to the detriment of its own population whose energy needs has not been satisfied. This is referred to as fuel poverty.

 It is unthought-of to think that in Cameroon, since 1976 when oil was first discovered in the country, the company allocated to exploit the crude and market has been a French company, and crude oil in Cameroon could not be transformed into secondary energy for end users in the country. The argument being that Cameroon’s crude oil is too heavy, and the required industry and knowledge for its processing is not found in the country. This makes it justifiable why almost all of Cameroon’s crude energy has to be exported, and in return, Cameroon has to import 90 percent of its oil from neighboring Nigeria for domestic consumption (Nkue et al, 2009).This has a negative impact on the population both in terms of affordability and pricing of energy supply. This means that Cameroon as an oil exporting country cannot even satisfy the energy needs of its people. A few thermal plants in the country which acted as support generators for electricity production were even complained of consuming a lot of oil, thus forcing the government to think of other possible ways to secure electricity production in the country during periods when the water capacity in existing dams could not support the existing electricity grid. The existence of a situation where basic modern energy such as electricity cannot be generated and supplied for basic consumption has been termed as “energy poverty”.

**Energy Poverty**

There are different definitions to the concept of energy poverty. By the appellation of the word, it can be understood to mean the lack of access, insufficiency, or complete absence of one’s energy needs. Energy poverty is a concept that connects poverty and energy. It could be defined as the inability to access modern forms of energy such as electricity. (OECD/IEA, 2010).The concept is not a widely recognizable one (Pedersen, 2010).However, some definitions exists and some of them address the concept in different context. It is within the ambit of this context that we found the concept as important to this thesis.

 The International Network for Sustainable Energy (INFORSE) defines energy poverty as:

… the un-ability to cover basic energy costs to keep homes adequately warm, cook food and have light”. It is also defined as households energy costs above 10percent of disposable income, transport fuel not included ( [www.inforse.org](http://www.inforse.org), 2009, Pedersen,2010)

The definition ties partially with the Sub Saharan African context, where most areas still do not have modern form of lighting, and cooking is done mainly from fuel wood. Even for the minority of urban dwellers who use gas in cooking, the prices are still very high, and basically unaffordable to the poor who live on less than two dollars a day. Cameroonians pay a high cost for lighting as well as cooking (Ngala, 2009) and according to the electricity company AES Sonel, electricity consumers will pay less if they were to turn off home appliances at night such as television, security lights, fridges, and fans in order to benefit from low electricity bills ( AES Sonel Communique on Cameroon Radio and Television, 2006). In a country where about 45 percent of the population are unemployed (World Bank, 2003) those who can afford the modern form of energy and can guarantee payment of bills should be the employed. But taking into consideration other factors such as the number of persons per household, the number of appliances connected, the amount of energy consumed by each person, the duration of uninterrupted energy supply, if we were to calculate the amount of income spent on energy, we can undoubtedly say that Cameroon is suffering from energy poverty. This strategy of rationing electricity at night goes on to explain that lighting at night is still a major problem for those with access.

 It is equally important to note that energy poverty is not necessarily limited to the prices paid for consuming energy (Patrick, 2011), but we would also think that subscription prices sometimes have prevented many would be users from access. In Cameroon urban and rural areas, the subscription fees to get electricity connected to private home stands approximately 200 dollars (Cameroon’s Ministry of Energy, 2008). This fee is payable to enable the electricity company to tap electricity from nearby installations, provide a pole and a meter to read the units. This fee depends on the distance between your home and the nearest electrical installation center. The further your home, the higher you will be charged for poles and other accessories for tapping the electricity especially as the starting sum for subscription is too high. Consequently, many people resolve to the high risk method of personally tapping directly from the main lines. Others proceed through the method whereby a number of households get their connections from a single house with subscription.

The bottom line of this all is that, when all the households are consuming electricity at once, either there are some appliances that cannot work, or there could possibly be short circuit and eventual explosion because one subscription is over charged. This is a typical Cameroonian context especially in the rural areas and unplanned urban areas. It is in view of these multiple energy related problems that the Baker Institute Energy Forum stressed that energy poverty also refers to poverty in terms of access and consumption, and all related constraints that households are subjected to, in a quest to satisfy their basic energy needs (Pedersen, 2010).

Looking at the concept from an economic development point of view, Jean-Marie Chevalier defines energy poverty as

The absence of sufficient choice that allows access to adequate energy services, affordable, reliable, effective and sustainable in environmental terms to support the economic and human development (Chevalier, 2009)

In further arguments raised, he noted that energy poverty could be explained by the fact that most people affected are low income earners, as such their income level determines their energy affordability (Chevalier, 2009).To an extend one may agree with his definition and argument. In the case of Cameroon, consumers do not have consumer’s sovereignty in the energy sector. So their choices are limited to the services that are provided by the electricity company. This definition might however be so demanding in the sense that it seems to address a wide spectrum of domains which might contribute in making the concept unaccepted by many. For example, if we are looking at energy poverty as lack of access to modern form of energy, and we bring in the example of three societies: one which has electricity generated from a thermal as well as nuclear plant, another whose electricity is mainly from hydro-power, wind and solar, and yet another society with its owns own source being biomass residual; from the above definition, we may conclude that all three societies are experiencing energy poverty.

This is because maybe the first society using nuclear and thermal might be accused of having a source that is not environmental friendly even though all of its population have access to energy. An example could be the recent Japan nuclear crises.

In the second case why hydro and solar are the main source of energy, climate variations could affect its ability to be reliable and efficient. An example could be Cameroon which generates 95 percent of its electricity from a renewable source hydro, but which is often plagued by constant power failure due to low water level. The conclusion in this second case will therefore be that the choice of energy is “sustainable in environmental terms”, but not reliable and efficient.

In the third case which involves a society that uses biomass residual as energy, this may be say a village found in the heart of the Amazon forest, with sufficient residual fuel wood for lighting, cooking and heating, but again the question will be whether the cutting down of the forest is environmental friendly?

It is with existing complexities such as the above analyses that finding an agreed definition for energy poverty as well as agreeing on the concept is difficult. It is against these arguments raised that the Baker Institute Energy Forum came up with different definitions of energy poverty based on specific area of concern. They came up with two definitions: consumption based and sustainability based (Pedersen,2010).

According to the Institute’s consumption based definition,

a person consuming below the average level of energy consumption of the poor for lighting, cooking, transport and livelihood can be considered a person in energy poverty (The Baker Institute Energy Forum, 2010).

On the other hand, sustainability-based energy poverty can be referred to a person consuming below per head sustainable energy available (The Baker Institute Energy Forum, 2010).

From the definitions so far, some important aspects to note if one were to come up with a different definition would include, the places and people concerned, the sources of energy in question, the degree of access, and the price paid for energy services in order to determine who can be considered as energy poor. However, all the above definitions describe the energy situation in Cameroon which upon analyses at the end, we shall be able to determine whether Cameroon is an energy poor country or not.

Additional explanations why the concept has not gain a wide recognition by many can be explained by a number of reasons such as the fact that the provision of accurate and detailed information on energy poverty has been lacking, and such provisions would have had a positive impact on how the concept is viewed and analyzed by many. As a reversal to this situation (Patrick et al. 2011) holds that:

As a starting point, we underline the multidimensional nature of energy poverty, and the need to capture a range of various elements to adequately reflect the complexity of the nexus between access to modern energy services and human development.

While elucidating on the on how energy poverty should be regarded, they went further to explain that

 relatively limited attention has been devoted to capturing aspects related to

the quality of the energy services delivered and/or their reliability, as well as to the notion of

affordability.

A means of assuring energy security for the people, will be to focus on the derivational perspective of the poor, (Amand & Sen, 1997) so that the indicators pertaining to them could be collected directly: This could be achieved by use of an ideal energy poverty metric, whereby the services provided by energy companies are scrutinized, so that those consuming the energy can underscore what is important to them (Patrick et al, 2011).

To conclude on the concept of energy poverty, it should be noted that the thesis will make use of the definitions here but not limited to the above, because all possible definitions were not treated here. One element of energy which was considered in these definitions was the aspect of sustainability which will be treated as a concept below.

**Energy Sustainability**

 Energy has been the driving force behind the industrialization of many wealthy countries, and as time passes on, poorer countries are increasing their demand on the resources that provide energy in order to generate growth and development, as well as better the lives of their population (Jefferson, 2005). As the world’s population rises, so too is the increase in demand for individual energy consumption. The manner in which energy resources are managed could have a serious impact for the future. In recent years the quest to secure more energy resources, has led many countries to consider developing new technologies that have less negative impact on the environment. But one key aspect in energy consumption which has been puzzling the minds of many has been the question of how to make a sustainable use of energy resources today while securing that of the future? The answer has been to develop new technologies that can supply sustainable energy that guarantees the energy needs of the future generation, while preserving our existing environmental and ecosystems (Jefferson, 2005). This has been referred to as sustainable energy management. The concept of energy sustainability has hardly had a global acceptable definition. So in other to get the meaning in this thesis, we preferred to breakup this concept into two words, so as to get the meaning of one and apply it to the other. In this light, we chose to define sustainability.

 Sustainability has become very popular in research domains and in the development of environmental policy (Brown et al, 1987).It has been variously used in many different disciplines, and its definition and conceptualization could vary from one society to the other. However (Brown, 1987) insist that *“a useful definition must specify explicitly the context as well as the temporal and spatial scales being considered”*. He further notes that much of the available literature on sustainability have not actually defined the term, but rather have describe conditions that can lead to attaining sustainability. So in other to find the appropriate definition that tie with the context of energy, we would first look at a broader definition of sustainability in different contexts and try to extract its meaning.

From an agricultural perspective, sustainability can be defined as “the ability of a system to maintain productivity in spite of a major disturbance” (Conway, 1985). For agriculture to be considered as sustainable, land which is the main resource must be exploited in such a way that it does not lead to degradation, and in which case it should ensure that it is economically and socially acceptable (Brown, 1987).In this definition we are more concerned with continuity and maintenance. In the electricity sector in Cameroon, one of the major problems that suppliers and consumers both faced is the issue of productivity and maintenance respectively. In reference to the hydro system which generates electricity, in the dry season, continuous production of electricity cannot be guaranteed. Consumers cannot maintain their usual consumption rates because they are compelled to rationing. This definition is important to our understanding of sustainability in terms of production and maintenance.

Sustainability can also be defined in terms of carrying capacity (Brown, 1987) which is yet another concept whose origin is grounded in population biology. Carrying capacity was used “t*o describe the maximum population size that the environment can support on a continuing basis”* (Brown,1987)

If we are to apply this definition to the sustainability of solar energy generation for electricity, we will be more concerned with the issues of population size and continuity. In the case of Northern Cameroon, the capacity of the Lagdo dam which generates electricity for the northern grid cannot reach dispersed and isolated population areas. Therefore its carrying capacity cannot be said to be sustainable since it cannot support the maximum population continuously. In the sense of understanding what carrying capacity describes, one would be right, but as pointed out by (Mitchell, 1979), it is very difficult to come up with a definition of carrying capacity because *“there is no … standard approach of how it [can] should be calculated”* Therefore if sustainability was to be defined based on carrying capacity, it would be logical to argue that when talking about a given area, population or sector of pursuing an unsustainable energy policy, we must ensure that there is a standard approach for its measurement. Because of the complexity involved in the concept, (Brown, 1987) stressed that it is important to note that the carrying capacity of any given resource, region, or environment is subject to change. The reason, he argues, could be because of technology advancement or injection of capital in a particular sector, importation of different resources such as energy from other regions. To conclude he summarizes the concept to a linkage between *“human population with resource use”* (Brown, 1987).Therefore, within this context, we can generally define sustainability as the ability of a resource to continuously support the needs of a given population at a given time without posing a threat to the existence of the environment and future generation.

Sustainability has also been discussed in many energy researches. The concept quickly gained its importance as a response to growing environmental concerns over the fossil energy resources. The burning of these fossil fuel over long term could lead to an increase in the emission of carbon dioxide into the atmosphere, and over a longer period will result to climate change with negative impacts on humans, by means of decrease food production, flood and droughts, health risk and much more (Twidell and Weir,2006).Recognizing the significance of energy use and its impacts on the environment, over 150 countries signed a UN Framework on Climate Change as a first step towards addressing the issue of energy use ([www.ipcc.ch](http://www.ipcc.ch), 2011). Under this scope, the concept of energy sustainability can thus be defined under two perspectives: one which focuses on environmental concerns, and the other on social cohesion. However some authors prefer to treat the concept as one, because as it has been argued, energy connects with most sectors of every society (Twidell and Weir, 2006) According to (Jefferson, 2005), sustainable energy can be defined as “a living harmony between the equitable availability of energy services to all people and the preservation of the earth for future generations” (Jefferson, 2005). This definition combines both the aspect of providing energy to all people and at the same time protecting the environment for the future.

 It could be a difficult task to realize both goals considering that not all areas have the same energy resources. In the case of Cameroon, the southern parts of the country have enormous hydro resources which can generate electricity more than the northern parts of the country. Yet, electricity is not available to all in the southern part of the country. So the carrying capacity is there, but the sector lacks investment.

 Sustainable energy could also be defined as *“a transition from a global energy based on consuming depletable fossil fuels to a sustainable based on non-depletable fuels”* (Anderer et al.1981). This definition is relevant to energy resources such as oil and gas reserves which are highly consumed and have limited lifetime of a few decades. Because of this limitation, (Twidell & Weir, 2006) points out that economic prediction based on lifetime of fossil fuels, usually leads to higher prices, and in the long run lesser demand for them in return for more expensive and reliable sources. Through this definition, one thing which is important to note is the fact that these sources are finite. So they cannot meet the needs of the present, neither can we state what amount of the resource will be available for the future, since it takes many years to form significant quantities. Thus sustainable energy resources development needs to be encourage. These resources will include among others biomass, solar, wind and hydro. Though these are considered renewable and friendly by environmental campaigners (www.irn.org), the socio-economic as well as ecological degree of sustainability still raises many questions, whose response could determine how we define energy sustainability.

Taking the example of hydro-dam projects in Cameroon, we realized that the Bamendjim dam which was constructed in Cameroon is built mainly for electricity production and water supply. In the course of building, the issue of mitigation, settlement and compensation are not clearly defined. Taking the example of the Bamendjim dam built in 1972, the environment was badly damaged with millions of trees buried under water, because of stagnant water, the dams became breeding grounds for vectors such as mosquitoes, which spread malaria to the inhabitants nearer the dam sites, besides destruction of ancestral land, economically people were displaced from fertile lands to unfertile ones, and in the end, the populations stood to lose more than benefit. The World Commission on Dams in its report stated that on average dams do not generate sufficient power, or irrigate lands and supply potable water as the promoters of dam projects usually present them. Rather these projects usually drive a greater section of the affected areas into displacement and damages resulting from floods ([www.dams.org](http://www.dams.org)). One of the most serious ecological costs of hydro-dams in Cameroon is that of water flow and erosion. Because the Bamendjim dam was built on the mouth of the river noun, water down flow was disrupted, and each time the dam gates are opened, it causes erosion land degradation (Mphoweh, 2008).Important to note is the fact that most large dams in Cameroon have attracted the funding of the world bank, and other international financial institutions. As it came be realized, what drives their interest in these projects is not the capacity of these dams to protect the local environment, and ensure that the project is geared to providing energy to the rural population , but rather how profitable their investments could give them return interest.

Based on the above explanation it be concluded that, the concept of energy sustainability is subject to interpretation, and be applied only when comparing one area of energy resources to another. It may be defined at one point based on economic concerns, or social, or environmental. Quoting (Clark, 1985), about what definition might be given to sustainability, (Brown, 1987) concludes that no definition is explicit under a spatial scale considerations. He continues by saying that sustainability can be defined and measured differently all depending on the scale of concern. When referring to the definition in terms of social concerns, issues such as a minority population, race, income group or a specific geographic region might be taken into consideration. Defining energy sustainability, therefore, entails that some essential elements are met such as a basic support system, sufficient energy input, good energy policy, the political will, and technological transfer and population control.

**Historical overview of the electricity sector in Cameroon.**

Cameroon is endowed with a lot of natural resources such as oil, wood and hydroelectricity potentials. Oil is very important in the economy and accounts for one third of the country’s export followed by wood (IMF, 2000a, Pineau, 2002).The country’s hydroelectricity potential is considered to be the second highest in Africa after the DRC (Nkue et Njomo, 2009) and is estimated at 115,000MW (World Resource Institute, 1996) .Both oil and wood are important energy sources to the population, with wood accounting for above 76.9% of local energy consumption (IEA, 2001). Despite the country’s rich hydroelectricity potential, electricity generation and coverage over the national territory is still very low. Electricity production in Cameroon dates as far back as the colonial period but the much recorded history of transmission and distribution of electricity in Cameroon began with the state owned company Société National d’Électricité (Sonel).Sonel was created in 1974 to manage the production, transmission and distribution of electricity in Cameroon.It got its birth from a merger of two previous companies- ENELCAM and EDC .In 1975, POWERCAM was also dissolved and Sonel took over control of the sector (Pineau,2002).Sonel had an almost complete monopoly over the electricity sector in the country and this was reinforced by a law that was enacted on the 26 of November 1983 giving it this monopoly status.Before this law came into effect, the company had one share holder the French Development Agency (Caisse Française de Développement) which owned 7 percent (Pineau,2002).By then, electricity was generated mainly from hydroelectricity power stations. However there were some backup diesel plants dotted around the country with many of them connected to industries.Cameroon had two main power plants the Edea and Song-Loulou plants which were built on the river Sanaga.A third plant was later constructed in Lagdo making the number to three.The total capacity of electricity generated by these three plants stood at 719 MW, and till date that figure has not seen very little significant change.In the late 1980s and early 90s, Cameroon like many other African countries was hit by the economic crises, which greatly affected the energy sector. It became very difficult for Sonel to carry out new investments and push forward with new distribution. The production level remained stagnant. In 1994, the official currency of most French speaking African countries (CFA) was devalued to the French franc. This badly affected Cameroon’s external debt. According to the World Bank, (WB debt tables, 2003) Cameroon's external debt rose from 140.4 million U.S. dollars in 1970 to 9350 million U.S. dollars in 1995. At the end of 1996 it amounted to 9515 million. From 1988 to 1995 that is within a period of eight years the debt rose by almost 95 percent. Since the electricity company had most of its debts valued in the French currency, that devaluation meant multiplication of the value of its debts. This lead to a slowdown in the electricity sector, and rural electrification almost came to a halt. According to a report by IEA in 2001, the electricity company in Cameroon was only capable to provide about 4,5 percent of energy needs by 1998(Pineau,2002).Failure to get out of this economic crises, pushed the government to come up with proposals of economic reforms. The government submitted its package of reforms to the IMF and World Bank which included among others strengthening the macroeconomic sector and improving the social conditions of the population (PRSP, 2000). To realize this, there were some policies that were set out such as the promotion of privatization, reduction of government involvement in the economy and market deregulation (World Bank, 2000b).Most state companies were earmarked for privatization, and amongst them were public utilities like electricity, water and telecommunications (PRSP,2000).

 Cameroon’s electricity sector had its first official call for privatization in July 2000, when one member of the World Bank Group (The International Finances Corporation) launched an international bid for the acquisition of the country’s lone electric sector. Many bidders tendered in their bids, and six companies were pre-selected. Those selected included “Électricité Du France (EDF), Hydro Québec(Canada), AES Corporation (USA) Eskom(South Africa), Union FENOSA and SAUR (France)” (Pineau,2002)..In February 2001 the government of Cameroon settled on AES Corporation and on the 18 of July 2001, Cameroon ceded 56percent of it shares to the Corporation ([www.aes.com/sonel/](http://www.aes.com/sonel/) 2006).

Under this “new deal” which was masterminded by the World Bank and its partners, one would expect that, a change in hand will increase the energy output, and meet the energy needs of the population. The population expected an increase in rural electrification and extension of transmission lines. But this has not really been the case. Though it can be said that, with privatization the electricity sector in Cameroon had seen increase investments, it still falls short of the energy needs of the country as a whole. This led us into questioning whether privatization meant more access, better services, and a sustainable energy policy?. One of the possible answer to this question would be that; private companies always seek profit first, and IFIs always make sure they support projects whose rent ability is encouraging (Nzene,2005).Thus the electricity sector in Cameroon has been unable to meet the energy needs of the population because investors are keen to make sure that, they invest where they can reap maximum profit. This made us to question whether any IMF/World Bank sponsored projects have had any good public result in the short run. Looking from an in-depth analyses, (Pineau, 2002) pointed out that the IMF and World Bank set of reforms in the electricity sector in Cameroon was against good public policy.

**Generation, Transmission and Distribution of Electricity in Cameroon.**

When AES Corporation took over 56percent of the electricity sector in Cameroon, the hope was that Cameroonians will feel a positive impact, and most of the resources that could generate electricity will see new investments. But far from that, Cameroonians were rather phased out with constant electricity seizures and power rationing especially since 2006.The question one should be asking is “why there shortage of electricity supply by AES with hydro potentials at their disposal”? Generally, the hydro plants built to provide electricity cannot support the demand on the ground, coupled with the fact that a greater part of the electricity generated is consumed by industries.

 Electricity generation in Cameroon is provided mainly from hydro. About 95percent of supply from hydro and 5percent from conventional thermal. The structure is broken down as follows:

There are three hydro power plants,

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Grid** | **Production** | **Capacity** | **Transmission** | **Voltage** |
| South | Edea | 266 MW | 480 km | 225kv |
| South | Song-Loulou | 400 MW | 685 km | 90kv |
| North | Lagdo | 72 MW | 337 km250 km | 110 Kv90 Kv |

Source: AES Sonel (2006)

The two plants in the South are backed up by three dams-reservoirs; the Bamendjim, Mbakaou and Lagdo which are used for regulating the river Sanaga during periods of low rain fall.A fourth dam reservoir has been under construction in Lom-Pamgar that will see an increase of 170MW to the already 666MW generated by the two plants in the South. Upon completion, those most likely to benefit highest is the aluminium company which is hoping to boost up its production.

Besides the hydro plants, there are six diesel thermal power plants connected to the electricity network, and thirty-one isolated plants. With these structure in place, AES sonel has been managing the sector together with the government and its other partners until present. Technical data that were obtained from the electricity company as of 2006 presented Cameroon’s electricity sector as follows:

**Installed capacity**

 229MW from hydro, and 206MV from thermal

 power generated was 3685 GWH

**Length of Network Coverage**

 High voltage:1881km

Low voltage: 10721km

Medium voltage: 10330km

Number of subscribers: 553 186, served by 20 agencies and 117 office

Country’s Population: 19 million

Energy sold: 2799 GWh

Rate of coverage of the country:46%

Access rate of 15%, including just 4% in the rural area

Generation type, 95% hydroelectric and 5% conventional thermal.

**Source: (AES Sonel, 2006)**

From the statistics provided above, one could easily see that less than 20% of Cameroonians had access to electricity. Interestingly enough, out of the total electricity generated, an aluminium company ALUCAM consumes more than one-third of Cameroon’s total energy output (Ngala,2009). In addition to this, they pay 0.8francs CFA an equivalence of less than 1 US cent per KwH at a subsidise rate. On the country, ordinary Cameroonians pay between 10 to 12 US cents for same consumption. If we were to look back at the definition of energy poverty, based on these statistics, we will conveniently conclude that Cameroon is suffering from energy poverty.

 Though AES sonel is doing much to improve on the energy needs of Cameroonians, the energy sector in Cameroon, and the electricity sector in particular have done very little to address the needs of the majority who badly need electricity to improve their living standards. Not only has the company been unable to extend the electricity grid to remote area, but they have as well not shown any great interest of investing in new technologies in the energy sector that could affect the greater part of the population. Their main interest has been to satisfy the needs of the industrial sector more. For example, prior to the construction of the hydro dam at Lom-Pangar, AES sonel already signed an agreement with ALUCAM which is a smelting company owned by Rio-Tinto Alcan in Canada to boost up the industry’s production capacity. Lauding the construction project of the dam, the managing director of ALUCAM could not hide his happiness:

“This is a major development for ALUCAM. We have been longing to expand production from 90,000 tons per year to 300,000 tons. We couldn’t because of inadequate power supply” (Ngala, 2009).

While he was expressing such hopes on the construction of this dam, it should be noted that in 2006, two students were killed in confrontation with police officer in the eastern region of the country as students came out in protest against black-out.

That notwithstanding , Jacques Dubuc, spokesperson for Rio Tinto-Alcan operations in Europe, the Middle East and Africa justifying while the dam is important to the ALUCAM explained:

“If ALUCAM suffers such production cuts, it is not good news for the company and its shareholders... it is particularly not good news for the Cameroon government which will also lose money in export taxes”.

As ALUCAM hoped for the completion of the dam, other power consuming projects were underway while waiting for the dam to go operation in 2012 such as the Limbe Cement factory, iron exploitation in mballam and cobalt mining in Lomie.In a disapproval statement by the major in whose municipality the dam was being constructed, he expressed his dismay over the fact that companies were more to benefit from the project than the population; ”*Industry is desirable …but it seems like people are now being sacrificed on the altar of industrial expansion."* ( Essoka Goumone, mayor of Belabo )

 If the electricity company in Cameroon pays more attention to the energy needs of the industries than the majority of population, it cannot be over question because most of its funding comes from the French Development Agency, the IMF and World Bank, the African Development Bank and other IFIs. Because the country depends on such funding, it becomes difficult to convince donors to fund alternative energy sources, and since most funds are geared towards making profit, improving the electricity sector to remote areas nor developing new sectors such as solar energy has been difficult. It is based on this that, we shall use the theories in the next chapter to answer the research questions of this thesis, and by exploring new energy sources for Cameroon.

**Chapter Three**

**Theoritical Framework**

A theoretical framework is of great importance in social research. For the accumulation of facts, it is necessary to have a reference of existing theories, so that facts may become meaningful. Thus, they are designed to be self-consciously, error-seeking and self-correcting (Sabatier 1999, 2007). Within the context and ambit of the theoretical fields of productive power and resource curse, the gaps within the energy sector in Cameroon fits in and build the arguments for the underdevelopment of the solar energy sector in the country. However given the scope of this study, it is not possible to give a full account of the whole spectrum of theories that could explain the problem and therefore this theoretical framework will be limited to those theories which directly explained the reasons, conceptualization, and development of the energy sector in Cameroon. The underdevelopment of the electricity sector and particularly solar energy can be explained both by external and internal threats which may supplement each other. When such a situation exists, there is room for energy insufficiency which can lead to energy poverty. So the thesis made use of two theories which were deemed important.

**Theories**

**Productive Power**

The theory of Productive Power came about with the publication of Frederiech List’s book entitled *The National System of Political of Political Economy* in 1841.The departure point for this theory was a critique of the arguments put forth by Mercantilist and Adam Smith’s classical school of economics on how nations acquire wealth, towards a new direction of the world’s economic and political system, based on a more realistic and pragmatic approach (List, 1841). One of the ideas behind his theory was creating an “ideal system in which developing countries throughout the world might achieve economic success” (Boyles, 2010:1).The theory was a one of Lists proposal for the national economy against Adam Smith’s theory of exchangeable values (International trade) which was developed in his celebrated publication entitled *The Nature and Causes of the Wealth of Nations* which List considered insufficient to explain the wealth of nations (Shaffaedin, 2000).

 The main argument of his theory of productive power was that

*“The causes of wealth* are something totally different from *wealth itself” (List, 1841).* List had disregard for a nation’s wealth by means of a cosmopolitan option which Adam Smith elaborated on, and he rather favored a nation attaining prosperity through the political process. Comparing a nation to a person, he stated that:

A person may possess wealth, i.e. exchangeable value; if, however, he does not possess the power of producing objects of more value than he consumes, he will become poorer. A person may be poor; if he, however, possesses the power of producing a larger amount of valuable articles than he consumes, he becomes rich (List, 1841:22).

This gives us an insight into the reasons why most African countries are rich in natural resources such as crude oil, wood, cocoa and timber, but cannot transform these resources into riches because they lack the productive power to do so.This theory could be used to illustrate the case of the energy sector in Cameroon, which since 1976 when oil was discovered in the country, have depended on foreign expatriate to explore the resource because it lacks the productive power to extract the resources. Since that discovered that Cameroon’s crude is too heavy, and until date, Cameroon cannot refined its own oil from the country’s own refineries. Rather this crude is exploited and exported by foreign companies such as Total and they only pay back revenue into the system in the form of tax. And in return, Cameroon imports Cheap light oil from Nigeria for most of local consumption. The reason for this existing situation is the lack of the technical know-how and the capabilities to exploit these resources. List describes this as mental capital which is (List, 1841) is essential for generating wealth for nations.

To illustrate how mental capital works within the theory, List chooses to use the example of two land owners with savings and five children each, one chooses put his savings at an interest rate, while the other chooses to educate and trained his five sons. The conclusion he draws at the end is that the one who had put his wealth for interest in the short run will make more wealth, but in the event of his death, though he might be rich, there might be no possibilities of insuring that what he possessed will be maintained, or the interest he gained will be increased since his wealth is shared among his five sons, and bad management problems could probe up rendering them poor in the future. But for the other who had invested in his sons in acquiring skills and learning a trade, they have the potentials to transmit their knowledge and skills from one generation to the other with each generation climbing the ladder of wealth and knowledge. This is one area where Cameroon is still lacking. You cannot expect to improve the energy needs or the wealth of a country such as Cameroon when relying only on finite energy sources such as oil, without thinking of alternative sources of energy. Even in terms of mental capital, we realize that brain drain has absorbed most of the country’s mental capital. List likens this situation to the slaveholder who prefers to multiply the value of his exchange to accumulate wealth, by increasing slave activities in the short run, without thinking what consequences this will have on his future ability to get able and more slaves. The same goes for Cameroon that has relied solely on oil revenue for the last thirty five years. The oil has been over exported up to the point where, production has dropped considerably and it is estimated that by 2035, the wells will run out of oil (Nkue, 2009). To match up the theory with facts, it is important to note that, Cameroon’s oil sector has the resources in place (wealth), but the mere fact for over the years most of it has been exported to western countries, ties in line with List’s explanation of productive power based on the example of a rich person with wealth and a poor person with productive knowledge and at the end, the rich becoming the poor and the poor becoming the rich.

This example can be furthered explained with justifications such as the rising cost of fuel in an oil producing country like Cameroon; the shortages of cooking gas in many parts of the country, whereas in a country like France and USA that consumes most of the heavy crude from Cameroon, they are energy sufficient. Though the USA has large amount of unexploited oil reserves, because the country has a vision into the future, and want to ensure the prosperity of its citizens, they prefer importing energy resources from other countries through their oil companies that have the technology of extraction. At least not only in the oil sector, western countries have been at the forefront of coming up with alternative energy sources such as solar, wind power to meet up with the challenges of the present energy sources. In doing this they implore both mental and bodily power to achieve their goals. To List, the power to produce lies with the individuals of a nation, and how they desire their nation to be in the present and future. Questioning how nations makes wealth, List asks: *“What else can it be than the spirit which animates the individuals, the social order which renders their energy fruitful, and the powers of nature which they are in a position to make use of”* (List, 1841:25)?

It is this spirit that Cameroon like most African countries lack and that explains why most of them are considered poor though with resources. If we were to draw the example from the economic policies in 1970s, the quick conclusion will be that most developing countries focused more on the exchangeable value of their natural resources, which List’s productive power theory stands to differ with, but they did not look into the future, they lacked visionary individuals in the society that could make better use of the natural resources they had by bringing about policies that can generate lasting wealth, they lacked the mental capital (List,1841) .But western countries more or less possessed it. They have been able to secure the wealth of their nations and gain more because of their futuristic agendas. It will be the same with alternative energy sources such as solar and wind power. They have revolutionized these sectors and should it become a profitable area for generating wealth in there nearest future, they will become front runners and will get richer because African countries will pay a big price for technological transfer and trade in these sectors. List attributes all these to the productive power of individuals within these western countries. As he notes: ‘*The more a man perceives that he must provide for the future, the more his intelligence and feelings incite him to secure the future of his nearest connections, and to promote their well-being’.* (List, 1841:25)

Therefore it is not a surprise to see some parts of North Africa already an area of interest to the European Union, where they hope, they could solar-power European cities.

The above explanation on the theory of productive power is one main reason that’s answers the question of Cameroon’s growing energy crises and its inability to use alternative sources such as solar. The country has the energy potentials such as oil, hydro, solar,wind but lacks the productive power to harness these sources so that it can benefit the poor, meet the energy needs of the population and increase the prosperity of the country as a whole.

 Another issue which List raised that leads to answering yet another problem of energy crises in Cameroon is the role of institutions. List considered a prosperous nation not only by the amount of wealth it has gained by means of exchanged value, but also by the level to which it has developed the institutions that produces power. While challenging J.B Say’s views on material and immaterial wealth, he noted that that “…*although laws and public institutions do not produce immediate values, they nevertheless produce productive powers…” (List, 1841:34)*. It could explain, as well as be an answer to why Cameroon’s energy sector cannot meet with up with its energy needs. The absence of strong institutions, a weak judiciary system, and corrupt government officials does not give room for initiatives that can create production powers by improving the other sectors of the economy that can generate wealth. An example can be the 1990s forestry laws in Cameroon that were passed before a rubber stamp parliament, giving many multinational companies access to exploit Cameroon’s timber (Djontu,2009). As List had stated; for a nation to develop its producing powers, it most try to develop other sectors of the economy and if possible set in protectionism policies in the short run (List, 1841), but the absence of institutions that can design such policies is considered a mental handicap for a country like Country. If we take the example of USA on the other hand, we would realize that even though US law makers do not generate immediate wealth, their role in voting certain laws or bringing some companies before congress for questioning for business mishaps like was the case with Toyota, and the setting up of a panel during BP’s oil spill is a strong indication to show that their mental capital is part of the country’s productive power. And until Cameroon develops its own mental capital that can secure the wealth of today, and make gains for the future, it will still remain powerless even though it has the energy resources, while the rich countries will continue to amass more wealth. As my one time lecturer Barry K Gills once said,

“Developing countries need more technocrats in the economy when it comes to international negotiations for their development…. because the proportion on negotiation tables iare sometimes like one delegate from a country against say 50 Americans experts on a single case on trade negotiations, and with this, there is little the latter can do to make any serious bargain” (Gills, lectures, 2008).

From the above preview, one can say that the arguments put forth by List has elaborated our understanding and created room to answers to one of the primary questions of the research which sought to know why energy sources are not developed in Cameroon despite the abundant sources of energy the country possesses. But List concludes his arguments by using the examples of other countries such as England to illustrate that a country needs more than wealth to be wealthy. As Boyles puts it “*if a nation is to grow in wealth and power, it must establish manufactures and a system of commerce to complement agriculture” (Boyles, 2010:8)* That is to say the country should possess the power of production. Thus List’s theory of productive power can be summed to the conclusion that success lies more with producing wealth than owning wealth.

One of List’s remedies to generate wealth is through having mental capital and combining it with resources (wealth) to become wealthy. With the situation of the energy crises in Cameroon, one way of handling the problem from a theoretical approach can be to create a strong and goal-oriented inter-ministerial panel on solar energy development with the main aim of securing the energy needs of the future especially for the dispersed zones exploiting all necessary means available like utilization of sun, research and subsidy to stimulate the sector. Corporation with neighbouring countries such as Chad can also be strengthened together with other international partners to acquire the necessary technology (producing power) for solar energy development.

From the above discussions, two considerations (power of production and mental capital) have been raised in the theory that helps us in understanding why Cameroon suffers from energy poverty and why alternative energy such as solar is not well developed in Cameroon, but this does not limit the problem to just that, since the energy sector is closely related with other sectors such as agricultural, commerce, transport, environment and social domains. To address the problem will require a broad spectrum of theories that could equally be applied to provide further answers to the problem raised.

**Resource Curse Theory**

**A Review of the Theory.**

The resource theory is a theory that was developed and accepted by many scholars around the 1980s attributing a country’s endowments with natural resources such as oil, timber and minerals as a curse than a blessing for its economic development (Rosser,2006).The theory suggested that countries that possessed rich natural resources were more likely to pay greater attention to this resources while neglecting other sectors of the economy with no resources; the outcome being a negative economic development (Villumsen,2010). Auty in his publication entitled *Sustaining Development in Mineral Economies: The Resource Curse Thesis,* maintained that since the 1960s, efforts by developing countries to attain post-war industrialisation has not been met, with suggested evidence indicating that many countries with natural resources do not only fail to benefit from their resources, but *“they may actually perform worse than less-endowed countries”*(Auty, 1993:, Kuwinb,2010:29).A great amount of literature (Sachs and Warner,1995,1999, Busby et al, 2005) suggests that most countries whose economic policies are closely tied with resource rents, end up with a dysfunctional state behaviour ( Robison et al, 2006).Resource curse theory also known as the ‘paradox of plenty’ according to Villumsen, is a multidimensional phenomena with different mechanisms that relates a country’s negative economic, political and social performance to its possession of natural resources (Villumsen,2010).From a broader perspective, evidence to support the linkage between a country’s endowment with natural resources to the ‘resource curse’ has been treated in many different ways by different authors, and can be narrowed down to two models: economic and political mechanisms .

The early arguments developed under the economic mechanisms dates back to the late 1980s when some authors such as W.W Rostow (1961), Belassa, Bela (1980) were of the opinion that natural resources could enhance the industrialisation process of a country. They attributed this to the fact that governments had more challenges to manage the revenue from their own resources, and from a neoliberal critique, government’s involvement in economic planning and development was disadvantageous (Auty, 1993), as such private management could see better management and speed up industrial advancement. Auty’s analyses drew him to the conclusion that structural policies of neo-liberalism would be a way of resolving the problem of resource curse (Kiwinb, 2010).The energy sector in Cameroon, is one the sectors that suffered from resource curse, because of the government’s high dependence on oil which remains the country’s main export accounting for about 7,5 percent of total GDP in 2004 (Cosse,2006). Under the economic mechanism of resource curse, four important elements were identified as bases between theory and practice. These included the ‘Dutch disease, unstable commodity markets, increased foreign debts and the poor economic linkages between resource and non- resource sectors’ (Villumsen, 2010:14-15).

Cameroon is one of such economies that got entangled in these mechanisms, and as a result, the electricity sector felled prey to it, starting with huge funds dedicated to dam projects while other sectors were neglected, acquisition of loans with dependence on oil revenue to pay off loans, eventually affected by oil shocks, leading to unsustainable foreign debts, and finally leaving a negative impact on other sectors such as health and education. The first economic mechanism that explains the resource curse theory is the Dutch Disease. It is a term that came into existence between the 1960s to 70s when the Netherlands plunged into an economic down turn as a result of the discovery and development of large gas fields which saw a sharp increase in government revenue without a corresponding increase in the manufacturing sector. When revenue flows into an economy from natural resources in an unregulated rate, and attention is not paid by injecting more capital into the agricultural and manufacturing sectors to increase in productivity at a low cost, the effect would be a decline in the functioning of these sectors because the resource sector has attracted both labour and capital from these sectors (Ross, 2006).The obvious result would be an upsurge in the prices of local goods and services and living cost(Kojucharov,2007). This is exactly the situation that Cameroon faced since 1976 when oil production began. The exportation of the heavy crude oil left the agricultural sector vulnerable.(Nji, 2009). The effects were not only felt in the manufacturing sectors, but as well in public utilities and lately in the energy sector itself. Government secured loans for the development of the oil production company SONARA, and the agricultural bank (Credit Agricole) suffered from a series of financial problems leading to its closures (Nji,2009). Government employees saw an increase in their salaries, and so too was the prices of locally made goods. The situation persisted and reached the climax in the 1990s when most public companies were placed for privatisation such as the energy sector.

 Another dimension of the resource curse economic mechanism is the unstable commodity markets which the prices of some these natural resources like oil and minerals are faced with. Since their prices are not determined by domestic markets, but rather by international markets, these products are subject to market fluctuations (Villumsen, 2010). This explains why most oil producing countries were greatly hit by the oil crises in the 1970s and early 80s.The explanation thus goes that that, international shocks could have a serious impact on the revenue in-flow in an economy, thus making natural resource dependent economies such as Cameroon prone to economic shocks (Kojucharov, 2007). For example, Cameroon’s budget relies mainly on tax revenue from oil which as of July 2010 amounted to XAF 289.4 billion representing 71, 1 % of total projected revenue, when compared to 2009, showed a decline of about XAF 2, 4 billion. (http://www.africaneconomicoutlook.org/en/countries/central-africa/cameroon/). Therefore any problem at the international scene such as the recent financial crises would have a negative impact on the oil revenue of a country, thus supporting the fact that oil prices are volatile, and changes in its prices affect negatively the amount of investment which other sectors in an oil economy like electricity receives (Villumsen,2010).

Because of the above condition, most countries tend to end up with increased foreign debt. The explanation holds that resource dependent economies have in most incurred more public spending during peak period when resources experience very high prices, and so when the reverse occurs, most government in order to meet up with their spending, fall to budget deficits (Nchichupa, 2008). Dependency theorists describes this situation as the exploitation by dominant states over under developing countries, but authors who back the resource curse theory attributes it to weak government with corrupt political leadership(Robison et al,2007).

Another explanation that could help us understands the underdevelopment of the solar energy sector in Cameroon is the economic mechanism that describes the relationship that exists between resource and non-resource sectors in a resource economy. Linkages between these two sectors was identified as a problem arising from resource curse because the resource sector often drew the attention of the state, and finances from this area in most cases was never well spent in other sectors. A number of reasons account for this, firstly labour in the sector was mainly from foreign expatriates, and because the sector takes in a limited labour force, capital tend to be concentrated in the hands of a few, and as Hirschman (1958) pointed out, multinational companies play an important role in transferring benefits from the sector away from the resource country. In the case of Cameroon, three companies oversee oil production in the country; TOTAL with a share of 68% of total production, Pecten/Shell Cameroon 23 % and Perenco 9%. In all of these, the government holds only 20 percent shares through the national oil company which known as Societe Nationale des Hydrocarbures (SNH).From the above, it can be easily be deducted that a greater share of the oil profits are owned by multinational companies and so these profits will not be invested in other sectors that can benefit the poor population in resource countries, since companies are foreign owned. Therefore, a combination of the above mechanisms can therefore explain why despite the fact that Cameroon is energy rich, its population are still energy poor.

Besides the economic mechanisms, there are also political models of resource curse. The political model among other considerations, looks into the political leadership of a country and their managements of revenue that arise from natural resources. A substantial literature has been developed pointing to the fact that resources revenue creates authoritarian rule; (Ross, 2001) and politicians are capable of using revenue from nationally owned resources such as oil, minerals to influence and the direct politics in such countries. While Ross points to the fact politicians are capable to use the revenue to impede democracy by means of repression of the population, or to pursue a modernization process that the population might not have a say in, Robison stresses the fact that resource boom especially in developing countries actually gives politicians an autonomy over extraction, and they use the revenue to trigger political incentives in different ways (Robinson et al, 2006). They discuss in detail how politicians most especially those who have been in power for so long use revenue generated from resource boom to seek for re-election by spending it on the population. They pointed out that such income can either be consumed or distributed (Robinson and Torvik, 2005). By distribution, they choose to elaborate it under what they called ‘patronage’ as a means of influencing the result of elections. Robinson notes that politicians could chose to patronise employment by allocating lucrative jobs to members of his circles, and this could result into the multiplier effect (Robinson, 2006). By patronage, he explains; many international relation authors have consented that it refers “to the way in which party politicians distribute jobs or specials favours in exchange for electoral support” (Weingrod, 1968:379).This situation can have a negative effect on the development of a country as well as its national income. This has been one of the major challenges Cameroon has faced since independence. In fact it is well documented that in a country like Cameroon where tribalism is so visible with over 290 ethnic groups, the ruling political class have over the years institutionalise tribalism, corruption and misallocation of the country’s resources (Ateba, CRTV morning safari program, 2008). This explains why key political, economic and military positions have always been maintained by the president’s close aides. This kills democracy, and creates political institutions that are in place to protect the political interest of the ruling class, and as a result, laws might come into effect design purposely to serve this purpose. (An example could be the 2008 constitutional changes that took place in Cameroon allowing the current president to extend his mandates after spending 28 years in office). This view is accepted by many, and even Auty brings out evidence in his analyses to support that “public employments can be a political appealing way of distributing rents”(Auty, 2001:135) though with serious social negative impacts.

Apart from the above, the role of natural resource income in promoting civil ways, cannot be underestimated. In fact the increasing civil wars and the birth of many rebel movements in different parts Africa have been mainly attributed to the fact politicians tend to either use the resources disproportionately or greed cause internal groups form rebel movements, since they know, if they control a few sources of these resources, they could actually fund their movements. Some authors amongst whom are Collier had conducted investigations into the causes of civil wars, and his conclusions were that natural resources was an inviting source of rebellion in countries with abundant natural resources, and such countries were more prone to civil wars(Collier,2000).Examples could include Nigeria, DR Congo. In other cases, the connection between resource income and the military have been seen in situations where politicians prefer to use the military as a weapon to suppress the rest of population, or use excess money from natural resource rents military spending. Again Cameroon experiences this type of resource curse effects.In Cameroon, the 20% share of oil revenue under the auspices of the SNH is directly placed under the presidency of the republic, and the presidency can decide to ask for disbursement of funds from this national oil company to finance military projects.This gives room for corruption (Cosse, 2006).And to add more, the military remain the only public sector employees whose salaries have not been slashed until date following the economic crises that hit the country in the 80s and all public sector workers had their salaries slashed by up to half under the austerity measures. This is a true testimony that explains why in a country like Cameroon, the ministry of defence and employees in this public sector are highly favoured.

After presenting a selected amount of reviewed literature relating natural resource income to economic and political development of resource economies , we found similar meaning between the case under study and the views expressed by key authors in this theory like Sachs and Warner who concluded that after 20 years of evidence there were all reasons to affirm that the abundant of natural resources in an economy helps in depressing growth(Sachs and Warner, 2001).They even went further to stress that though the theory was not a ‘bulletproof’, the evidence to support the theory were quite strong(Kiwinb,2010:56) Other authors such as Giles Atkinson support the theory by illustrating the negative side of how income generated by means of rents as GDP in such economies turns to regress growth rate (Kiwinb,2010). Under this present study, with the above views, we could ascertain to the fact that resource curse theory offers a better explanation why some sectors of resource rich countries are lagging behind, while others are not. The evidence presented here can thus help us to understand that the underdevelopment of the electricity sector in Cameroon owes much of its blames on the implication involved with resources rents and the manner in which economic and political mechanisms overlap with each other. However, not all authors share these views, as some literature have examined other resource rich countries such Norway to differ with the majority of authors who support the theory by showing how Norway effectively managed its income from natural resources (Villumsen,2010). Could it therefore be said that, the resource curse theory relates more with developing countries?

**CHAPTER FOUR**

**Solar Energy in Northern Cameroon**

In this chapter, we discussed about the availability of solar energy potential in this part of Cameroon, based on available data that points to the fact that the region has the highest level of solar radiation, and ideal for solar installations. We shall look at the solar potentials of two regions- Maroua and Garoua located in the northern part of Cameroon.

**Summary Presentation of Study Area**

 Northern Cameroon is a general term used to describe three of Cameroon’s ten regions. It is made up of Adamawa with capital in Ngoundere, North with headquarters as Garoua, and the Extreme North Region with capital in Maroua. For this case study, we have chosen just the North and Far North Regions; because of their usefulness in as far as solar energy sources are concerned.

**Far North Region**

**Climate and Relief**

The Far North region is characterized by low lying plains and plateaus and mountains. Its vegetation is dominantly sudano-sahelian. Annual rainfall levels range between 435-810mm and temperatures goes up to about 45°C between February, March and April (UNDP, 2000 and WFP, 2002 as cited in Abeh, 2003).It has two distinct season, the dry and rainy seasons. In the Sudan parts of the region, there is much cold and dry weather whereas in the Sahel there is hot air, with much rainfall that sometimes leads to floods (Gwanfogbe, 1983).Over the years, agricultural activities, human activities and the effects of the Sahara desert have led to the desertification of the region, forcing the government to seek for aid to launch the operation green Sahel which is aimed at restoring the region’s lost forest (Abdou, 2001).With the encroaching desert, the population especially in the rural area have been faced with serious fuel wood shortages. This problem only comes to add to other environmental, social, and economic problems. For example, the Lake Chad which is a major source of fishing area for the region has been witnessing seasonal shortage of water, making many to believe that if human activities coupled with climate variations were to continue, the lake risk drying off someday.

**Demography**

The Far North Province is the second populated region in Cameroon after the capital Yaounde. It has a total population of 3,480,414 representing 17,9 % of the total population with a population density of 101,6 inhabitants per kilometre square. Its surface area is approximately 34262km square -equivalent to 7.4% of the total national surface area (Results of population census, 2011).As of 2010, the population was distributed as follows: 839 031 within the urban milieu and 2 641 383 in the rural milieu. Even though there are economic activities carried here, most of the population still remain in the rural areas and the region was rated as the poorest region according to figures from the country’s poverty index in 2001 which showed a poverty rate of 49% of the total population. Equally important to note is the fact that the region has the highest rate of illiteracy in the whole country (Abeh,2003)

**Agriculture and Economic Activities**

Most residents in this region depend on sustenance farming for survival, and crops cultivation varies. Cereal production is dominant in this region’s agricultural activities, with millet being the most favorable. However, there is also the high production of maize, rice, groundnuts and sorghum( Abdou, 2001)In addition to the cereals, there is high cotton production, and the cotton seeds are also transformed to produce cotton seed oil. The capital Maroua is considered an important commercial centre to Cameroon’s cotton industry and play host to the country’s main cotton industry SODECOTON, and other textile industries. The men in this area are highly involved in cattle rearing especially the Fulani and mbororo tribes men.(ibid).Their activities have led to the development of small tanning and leather industries products of cattle to process by . There exist some plants like the cement factory, and different mills where rice is processed.

**Administrative Set Up**

Maroua is the capital of the Far North region It is divided into 6 departments, 40 sub departments and 4 districts.

**North Region**

**Geographical Situation:**

 The North region is located between latitudes 10° and 13° north of the equator and between longitudes 13° and 16° east meridian. It covers an area of 66 090 kilometer square, representing 14, 2% of the total surface area of the national territory.

**Climate**

It has a tropical climate, which is make by two season, dry and wet seasons. Rainfall rates between 7000-1600mm.The wet season runs from June to September making it the shortest in country while the dry season runs from May to October. The dry season is often preceded by the harmattan winds.

**Demography**

It has a total population of 2 050 229, representing about 10,6 % of the total population(Result from Population census,2011).Its population density is about 31,0 inhabitants per kilometer square. It is the fourth largest region in the country. Poverty index of the region in 2001 stood at 44% of the total population, making it the second poorest region in the country (Abeh,2003)

**Administrative Divisions**

Garoua the capital of the North Region lies at the cross-road between Maroua and Ngoundere, and shares a border with neighboring Nigeria and Chad. It is made up of four administrative departments.

**Economic Activities**

The economic activities in this region are similar to those of the Far North region. The population relies on subsistence farming as well as cattle rearing. Rice, Millet, and Sorghum are the main cash crops in this region. Garoua which is the capital has a port, considered the third in the country, which serves for commercial activities between Chad and Nigeria. The economy is also stimulated by the weaving industry, while artisanal businesses are quite present. There is leather and spinning industry and many some industrial research centres.

(Tansi, 2010).The Ladgo reservoir on which the Ladgo dam is built serves as an important fishing area for the inhabitants while hydro electricity is generated from the dam for the three northern provinces.

**Energy Situation in North and Far North Region**

The Northern Regions have been faced with similar problems of energy crises like the rest of the country does. The region suffers from both shortages of petroleum products as well as electricity shortages. In terms of electricity supply; the two regions are supplied by transmission from the Northern grid hydro plant of Lagdo which has a total capacity of 72MW spread over a distance of 587 kilometers. However, these two regions according to AES Sonel, the main electricity company are amongst the lowest consumers of electricity in the country, with the Far North Region having the lowest level of rural electrification. Based on the fact that the regions have the highest potentials of solar energy, what are the scenarios for generating alternative energy for these regions from solar?

**Solar Radiation Data for Garoua and Maroua**

In order to assess the solar capacity of a given area or region and its potentials to generate electricity, the measurement of the intensity of solar radiation must be obtained. In Cameroon, sunshine measurement were available as from 1955 through the department of national meteorology (Steedman,1979).The first ever measurement of solar radiation in Cameroon were carried out between 1969 to 1973 in Yaounde (Ibid).Solar radiation was first determined with the aid of a pyranometer measured from a horizontal and tilted surface in (kWh/m²/d) kilowatts per meter square per hour, and averaged daily, monthly or annually (Ibid).Over the years technology has evolved, and NASA has been able to collect the results by use of satellites making it possible get an accurate data on the regions under study.

According to data collected by NASA on Cameroon’s solar potentials, results showed that the country had the potential to generate solar energy, that can go above average, with the northern regions having the most positive results, and Garoua outstanding with the highest level of radiation valued at 5.75kWh/m²/d, followed by Maroua (Tansi,2010,Djuikom,2007). The following data below carried between 2009 and 2010 presents us with the following:

Source: Courtesy (Tansi,2010)

The above figure shows that Maroua and Garoua have the highest radiation level of solar radiation of kilowatts per hour per meter square on a daily when compared with figures from eight other areas in different regions. Also looking at the table below based on a yearly rate, the two regions had the highest rate in terms of radiation and amount of electricity that it can export for grid connection per meter square. This made the case ideal for case study.

**Solar Analysis for Cameroon’s 10 Regions for 2009**

|  |  |  |  |
| --- | --- | --- | --- |
| Region  | Location  | Annual solar radiation - horizontal kWh/m²/yr | Annual electricity exported to grid [MWh]  |
| **Extreme North** | **Maroua** | **5.44** | **3,342** |
| **North**  | **Garoua** | **5.75** | **3,376** |
| Adamawa  | Ngoundere | 5.65 | 3,340 |
| North West  | Bamenda | 4.96 | 2,953 |
| West | Bafia\* | 5.00 | 2,927 |
| Center | Yaounde | 4.67 | 2,730 |
| Littoral | Douala | 4.28 | 2,521 |
| East | Bertuoa | 5.02 | 2,936 |
| South | Ebolowa | 4.63 | 2,689 |
| South West | Fontem | 4.75 | 2,819 |

Source: (Tansi,2010)

Figure below indicated that between the month of January and May radiation in Garoua was above average, considered good enough for electricity generation, meanwhile from June to September, it felled a little below, then from October to December, the rate again rose above average.

**Monthly Solar Radiation Values For Garoua**

The two tables below presents a monthly assessment of solar results for Garoua and Maroua respectively, from a daily rating which was summed up to give us the annual figures. The annual solar radiation level for both regions indicated that Garoua was a better choice to Maroua, even though the two regions could be able to generate their of electricity based on the total radiation level available in the region.

**North Region-Garoua**

 **Monthly Assessment Results of Solar For Garoua**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Garoua** | **Month** | **Daily solar radiation horizontal** | **Daily Solar radiation-tilted** | **Electricity exported to grid** |
|  |  | kWh/m²/d | kWh/m²/d | MWh |
|  | January | 6.07 | 6.70 | 0.347 |
|  | February | 6.36 | 6.53 | 0.304 |
|  | March | 6.50 | 6.15 | 0.317 |
|  | April | 6.24 | 5.44 | 0.276 |
|  | May | 5.78 | 4.74 | 0.250 |
|  | June | 5.37 | 4.31 | 0.221 |
|  | July | 4.94 | 4.05 | 0.217 |
|  | August | 4.83 | 4.16 | 0.225 |
|  | September | 5.16 | 4.72 | 0.245 |
|  | October | 5.70 | 5.65 | 0.297 |
|  | November | 6.17 | 6.69 | 0.333 |
|  | December | 5.93 | 6.68 | 0.345 |
|  | **Annual** | **5.75** | **5.48** | **3.376** |
|  |  |  |  |  |
| Annual solar Radiation-horizontal | MWh/m² | 2.10 |  |  |
| Annual solar radiation tilted | MWh/m² | 2.00 |  |  |

**North Region-Maroua**

**Table :Monthly Assessment Results of Solar For Maroua**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Garoua** | **Month** | **Daily solar radiation horizontal** | **Daily Solar radiation-tilted** | **Electricity exported to grid** |
|  |  | kWh/m²/d | kWh/m²/d | MWh |
|  | January | 5.61 | 6.19 | 0.322 |
|  | February | 6.24 | 6.46 | 0.301 |
|  | March | 6.56 | 6.25 | 0.320 |
|  | April | 6.31 | 5.53 | 0.278 |
|  | May | 5.96 | 4.91 | 0.256 |
|  | June | 5.50 | 4.43 | 0.226 |
|  | July | 5.03 | 4.15 | 0.222 |
|  | August | 4.85 | 4.20 | 0.226 |
|  | September | 5.34 | 4.92 | 0.253 |
|  | October | 5.70 | 5.69 | 0.296 |
|  | November | 5.85 | 6.37 | 0.316 |
|  | December | 5.56 | 6.28 | 0.325 |
|  | **Annual** | **5.70** | **5.44** | **3.342** |
|  |  |  |  |  |
| Annual solar Radiation-horizontal | MWh/m² | 2.08 |  |  |
| Annual solar radiation tilted | MWh/m² | 1.99 |  |  |

From the above tables, it is evident that the two regions are suitable areas for solar energy installations. So how is solar energy consumed in these regions and who are the actors?

**The Use of Photovoltaic Solar Energy and Actors Involved in Northern Cameroon(Maroua).**

Though rich in solar energy resources as seen from the data above, the use of photovoltaic in the Northern region is still very limited. As of 2003, there were only 47 locations where PVs were installed and generating electricity. The PVs were distributed among the regions six administrative departments as follows:

Diamare 5%

Logone and Chari 17%

Mayo Danel 32%

Mayo Sava 10%

Mayo Kani 12%

Mayo Tsanaga 24%

Usage of PV in the region is divided between households, the public services, training centres and Non Governmental Organizations, as well as religious communities. Users of the PV in the region were the local community having above a quarter of installations, foreign expatriates had more than half of the installations, while business places had less than a quarter of total installations (Djuikom, 2007). However, other exploitation of the solar resources do exist such as the introduction of hotpots in the region since 2008 by some NGOs to the women of Maroua for cookery. The hotpot technology was developed and completed in 2004, and comprises of reflectors that captures sunshine and is ideal for cookery in areas like Northern Cameroon that has sunshine throughout the year.

Based on the above information about the usage of solar photovoltaic and other solar uses in the region, it is evident that despite the abundance of solar energy resources in the Northern region of Cameroon, its development and utilization is very low. A number of reasons exists explains this current, and will be analyzed in the next chapter of the study to help provide answers to the questions raised at the beginning.

**Chapter Five**

**Analyses**

The following chapter will present analyses of solar energy and the failure of its development in Cameroon especially in the Northern region. It will build on arguments raised in the theoretical part of this work, and will use elements of the productive and resource curse theories to form the structure of answers to the research questions. The structure will be based on each of the questions raised, and will be developed under separate headings. Analyses will be carried out at the technical, economic, environmental and political levels. At the end, this will definitely answer the main research question of, *Why is there a limited use of Solar Energy in Cameroon amidst the energy shortages in many parts of the country, despite the abundance of solar radiation in the country?*

**Technical Analyses**

When the construction of the three hydro plants in Cameroon, (Edea, Song Loulou and Lagdo and three other reservoirs dams) were completed, it was hoped that it will have the capacity to generate sufficient electricity in the country at the time, but the technicians did not envision a situation whereby the future energy needs of the population will surpass the actual total generation capacity of 932.7 MW. Furthermore, they did not strongly consider the possibilities of the water level dropping down either because of climatic variations or human activities. So over the years, the country had depended on hydro electric power as a reliable source of energy, and have only compensated for energy shortages with conventional thermal which accounts for about 5% of the total generation in the country. Therefore Cameroon’s annual electricity generation which currently stands at 3685 GWh have not had any alternative energy added to the figure say from solar or wind. The reason for this links to the fact that Cameroon is said to have the second highest hydro electricity potential in Africa after the DRC (Nkue et al, 2009). By technical analyses, experts in electricity generation holds that hydro electric power is more cheaper, easier, reliable and available for processing than other alternative energy sources, such as solar (Steedman,1979).

A sample analyses was carried in 2009 to assess the possibility of generating alternative electricity from solar panels that is equivalent to the amount of energy consumed in Cameroon from the combined hydro and thermal plants of the country. The results presents us with an interesting data that will be useful to answering our question. The technical analyses comprised of a solar module of BP Solar’s high-efficiency photovoltaic module SX3200 using silicon nitride multi-crystalline silicon cells with the following specification

**BP Solar’s SX3200 solar modules**

**Figure**

Source:Tansi,2010

Technical specification of brand new SX3200 solar :

**Performance**

Rated power (Pmax): 200W

Power tolerance: ±9%

Nominal voltage: 16V

Limited Warranty: 25 years

**Electrical Characteristics**

Maximum power (Pmax): 200W

Voltage at Pmax (Vmp): 24.5V

Current at Pmax (Imp): 8.16A

Warranted minimum Pmax: 182.0W

Short-circuit current (Isc): 8.7A

Open-circuit voltage (Voc): 30.8V

Temperature coefficient of Isc: (0.065±0.015)%/ °C

Temperature coefficient of Voc: -(111±10)mV/°C

Temperature coefficient of power: -(0.5±0.05)%/°C

NOCT (sir 20°C; sun 0.8kW/m²; wind 1m/s): 47±2°C

Maximum series fuse rating: 15A

Maximum system voltage: 600V (U.S. NEC rating)

**Mechanical Characteristics**

**Dimensions** Length: 1,680mm (66.14”)

 Width: 837mm (32.95”)

 Depth: 50mm (1.97”)

 Weight 15.4 kg (33.95 pounds)

**Solar Cells**: 50 cells (156mm x 156mm) in a 5x10 matrix connected in series

**Output Cables**: RHW-2 AWG# 12 (4mm² ), cable with polarized weatherproof DC rated multicontact connectors; asymmetrical lengths - 1250mm (-) and 800mm (+)

**Diodes IntegraBus™** technology: includes Schottky by-pass diodes integrated into the printed circuit board bus

**Construction Front**: High-transmission 3mm (1/8th in) tempered glass; Back: White or Black Tedlar; Encapsulant: EVA

Frame B Anodized aluminium alloy type 6063T6 Universal frame; Color: bronze

**Module warranty**: BP’s SX3200 has a 25-year limited warranty of 80% power output; 12-year limited warranty of 90% power output; and a 5-year limited warranty of materials and workmanship (Details obtained from Mario et al., 2006 as cited in Tansi, 2010).

The components of BP’s solar module is said to be more efficient when compared to other conventional solar cells. From the above technical details, analysis were made on how an isolated-grid generation of 2,000W could be generated such that efficiency could be rated at 95%.The findings indicated that ten of such BP solar 200W high efficiency PV modules (SX3200) would be needed at a total cost of FCFA 2,850,500 (Approx. €4,287.16).At this amount the cost of exporting electricity will be FCFA 40/kWh (€ 0.06/kwh).Based upon the above value, calculated from an illustration of a solar scheme on a horizontal location where houses are located within the same neighbourhood. Just by the fact that most of the population of Maroua have displaced settlements, to realise a project of this nature would require more than just what has been enumerated above. To realise a solar project in an off grid location, technical issues of price, products of solar panels or modules and place must be considered. To get panels that can have a life warranty of 12 years will require that someone with the technical knowledge be in place. Considering therefore a region like the Far North rated as the poorest region in the country, the limited use of PV can be justified. Based on this, the total increment cost of the solar project as have been demonstrated else well like in the Eastern Cape of South Africa, proved to be by far more expensive (Kalyegira and Gant,2010) than hydro, thus explaining why solar energy is limited in use in Cameroon. One of the main reason why these modules are even more expensive is the fact that, there are foreign technologies, and knowledge of it is not ´yet well developed in Cameroon, thus adhering to the theory of Productive power, that he who has the mental power owns more wealth than he who owns wealth in resources.

**Economic Analyses**

“The importance of mineral and energy mineral resources cannot be overestimated. Most critical among the resources is energy. Energy is the key which unlocks all other natural resources. Without it the wheels of industry do not turn, no metals are mined and smelted. No cars, trucks, trains, ships or airplanes could be built and if built, they could not move without energy ( Youngquist, 1997, cited in Tansi,2010)

The discovery of oil in Cameroon and the exploitation of other natural resources has played a very significant role in the macroeconomic functioning of the country, and without this natural resources, one wonders how the country would have managed its budget. As quoted above, energy is key in every sector of the economy, but incidentally the government of Cameroon has not paid too much attention to the electricity sector, and the population have not reaped much from the fall outs resulting from the sales of these natural resources such as the provision of basic and essential needs such as energy. Unlike the United States of America and Finland who developed their energy sectors and it was key in helping develop their countries (Pineau, 2002), the Cameroonian case has been different. The negligence of the state towards the electricity sector had even threaten one of the country’s leading industry (the aluminium industry ALUCAM) to the extend where shortages in energy saw production drop to below 40% despite the fact that ALUCAM is classified as the fifth sector in the country’s export. *Why would a state endowed with much natural resources such as oil, timber, coffee, cocoa and minerals fail to develop its energy sector?* How is the revenue from these resources managed, and how can a plan to expand the energy sector by including an alternative energy programme such as solar be made possible?

 Answering these question require us to look at some of the issues that were raised earlier in the resource curse theory. The theory had stated that management of income from natural resources has always been a problem for resource rich countries, and generally, the income never benefit the poor, and there is a chain of economic mechanisms that overlap each other making it impossible for such countries to effectively deploy sufficient funds to other sectors of the economy such as the electricity sector.

In Cameroon for example, oil revenue income has not been well spent and transparency has been lacking in the management (Cosse, 2006).When production of oil began in Cameroon in 1977, A stabilisation mechanism was put in place, managed by the CSPF stabilization fund (*Caisse de stabilisation des prix des hydrocarbures)* which is a unit under the national oil company SNH.This was put in place to avert the case of the effects of a Dutch disease, and to control the revenue in the event of price changes.But these units have not done so much in their capacity.Firstly, since the creation of SNH when oil production started in Cameroon, the first audit to be done by an international accounting company was only carried out in 1991 (Cosse,2006). This gave room for mismanagements since issues such as corporate tax and tax revenue passed through their services. Later in a bid to increase transparency, the company had to transfer all tax revenue to the treasury and into the public budget. Thus, they tended to neglect other sectors of the economy like the electricity sector. The SNH remained the only company from where cash hand outs from oil revenue are disbursed into different areas of the economy. An example has been presented below of how oil money was spent by SNH

Table 2: Cameroon: Cash Advances by SNH

(in percent)

|  |
| --- |
| 2003 2004 2005 |
| Presidency 21.7 37.5 24.8 |
| Ministry of Defense 34.1 32.8 63.5 |
| Cameroon Airlines 32.0 15.0 5.7 |
| Others 12.2 14.6 6.0 |
| **Total 100.0 100.0 100.0** |
| ***Memorandum items*** (In percent of budgetary allocation) |
| Presidency 44.5 71.1 70.2 |
| Ministry of Defense 59.7 54.0 92.6 |

Source (Staff Estimate, Cosse, 2006)

From the above figures, it can be deduced that the SNH spent quite a lot of the oil money for sectors other than the energy sector, thus confirming to the economic mechanisms of resource curse theory which points to the fact that resource rich income is never well spent in the sectors that will benefit the population. This thus illustrate that oil money had some sectors which it prioritise, such as the military, and as a result supports the assumptions of the theory that income from natural resources in resource rich countries always create a gap whereby resource sectors do not link up with non resource sectors which can lead to the Dutch disease. It thus explains why government has been unable to improve on the energy sector let alone developing alternative sources of energy, which is enough justification for the limited use of solar energy in the country.

 From a cost analyses perspective, it is necessary that to carry out a project on alternative energy in Cameroon, detailed and well defined financial cost evaluation be carried out to determined what it will require for the proper function of a solar system in any part of the country that has the potential to support such. The figures below obtained from previous studies revealed that the cost of energy development through different solar cells were more expensive than any other known technology

**Total initial costs of power projects.**

|  |  |  |
| --- | --- | --- |
|  |  |  |
| **Technology** | €/kW  | FCFA/kW |
| Fuel cell 8,712 | 579,348 |
| Gas turbine 1.224 | 813,960 |
| Gas turbine(combined) 864 | 574,560 |
| Geothermalpower 2.5921  | 723,680 |
| **Hydro turbine 1.584** | **1,053,360** |
| Ocean current power 0 | 0 |
| **Photovoltaic 6,552** | **4,357,080** |
| Reciprocating engine 108  | 670,320 |
| Solar thermal power 4,9 68 | 303,720 |
| Steam turbine 792 | 526,680 |
| Tidal power 2,952  | 1,963,080 |
| Wave power 0 | 0 |
| Wind turbine 1,368 | 909,720 |
|  |  |
|  |  |

Source: Adapted from (Tansi,2010)

Following the above costs, when comparing the average cost of Photovoltaic and hydro turbines installations of a 2000kw power project, PV will cost €13,104,000 (FCFA 8,714,160,000) while hydro turbine will cost €3168 (FCFA 2,106,720,000).The cost difference is so wide such that a country like Cameroon will not be able to encourage the development of solar energy for commercial purpose, thus giving us yet another justification to back up the limited development and use of solar energy in the country. If such a scheme were to be carried out, and we take into consideration the place (off grid) locations which in most cases are rural areas, the cost per kwh will be too high for the population to pay for. Given this high cost of production, distribution could be limited to the very few who can afford on a grid network. These challenges of costs are further compounded by the fact that PV unlike hydro plants usually have a shorter warranty period and weather the installation is on a grid base or as individual bases, product replacement, development of new technologies in the solar domain and competition could actually make its promotion actually difficult in a country like Cameroon, thus leading to questions about the financial sustainability of a solar project.

Besides the above points raised, the two main challenges facing solar energy technology the world over, are the issues of efficiency and storage technology.It is estimated only between 8-20 % of efficient solar energy can be capture from sunlight with the available technology in place for commercial purposes and up to 24 % for a single joint device ([www.globalization101.org](http://www.globalization101.org), Archer in Archer and Hill eds., 2001) So because of that, if solar panel had to be developed so that it should satisfy the energy needs of say the USA, detractors of solar energy believe it ‘would take about 10,000 square miles of solar panels—an area bigger than Vermont’ (www. globalization101.org).In addition to inefficiency, the unavailability of sunshine at nights and unpredictability of weather conditions are all obstacles that solar energy still has to overcome, and these problems are common phenomenon everywhere, thus are the same problems that will be faced in Cameroon as well. To break this obstacles therefore, there must be the continuous development of new technology and use of power mix to make it a viable source of energy, for example using battery for storage.

Despite the above reasons advanced why solar energy use has been limited in Cameroon and the above hindrance which the technology is facing worldwide, It still represents a source of clean energy and remains one of the renewable energy sources that can be ideal for off grid locations like the rural parts of Northern Cameroon. This technology gives users the possibilities of installing panels on a need basis, and one must not join the grid connection to get energy, as panels can be install on individual roof tops, and one must not have the same amount of capital like the rest of the society to get connected (ibid).Because of this, in communities where there are no connection grid, solar energy could step in and fill in the multiple gaps of energy needs. From a sustainability point of view, though solar energy might be expensive to process, the fact that it is natural makes it so good for emission offsets in the environment, these offsets can be tradeoffs with industrialised countries for projects under the Clean Development Mechanisms, which can actually see the cost fall down considerable. Should this happen, women will have access to energy with multiple uses, and it will improve their economic and social outputs.

**Chapter Six**

**Conclusion**

The thesis which was dwelt on the energy sector in Cameroon was set out to answer the research question *Why is there a limited use of Solar Energy in Cameroon amidst the energy shortages in the country, despite the abundance of sunshine?.* To attain the objectives and provide convincing answers, we implored the use of two theories-productive power and resource, to explain the reasons why Cameroon is endowed with high potentials of energy resources, but suffering from energy poverty. The theory of productive power carried with it explanations to show that technical know-how is an important ingredient for development of any sector, and so account partially for the reasons why Cameroon is energy poor, and why solar energy is in a limited use in Cameroon, while the theory of resource curse complemented the latter by linking economic and political mechanisms to support that natural resource rich countries can absolute be poor because of management and the negative influence of political institutions and leadership. With each of the arguments raised by the theories, it has been found from the analyses that both the government and external factors accounted for the energy situation in the country in different ways.

 Firstly, the shortage of electricity in the country especially during periods of low rain fall is largely explained by the government’s negligence of the energy sector which for years has been dependent only on the three main hydro plants whose generation capacity could no longer meet the energy needs of the industries and local consumption for the population. The fact that ALUCAM even consumed much of the electricity supply made it very difficult for the rest of the population not to suffer from energy poverty. The situation here may have arose from a number of possibilities, first of all climate variations might have contributed through low rain which the areas arounds Edea and the Sanaga have faced in the past years thus leading to a drop in the river levels, and so affecting the reservoir dams.

 Secondly, poor management of the electricity sector by the old state company Sonel, was also a contribution to the energy crisis in the country. During the period when it was active, because it was state managed, the company engaged in political electrification projects whereby the state disbursed money for regions of the country where the population expressed the desire to vote for the political party in place. This was most especially towards election period, unplanned promises of rural electrification were undertaken and shortly after elections, they were abandoned. This led to the embezzlement of funds from the company by people who claimed they were sponsoring the ruling party. Presently in Cameroon, there has been an ongoing clamp down on corrupt government officials, and some of the ministers during their trails have confessed for having been asked to disburse money from their Ministries for election campaigns (Siam Siewe, former minister under detention, testifying at a hearing in Yaounde High Court, 25/09/2010).As the political mechanism of the theory of resource curse suggested, resource income could actually be used for political reasons, and made to keep the incumbent in power while the other sectors of the economy simply will not have finances (Robinson, 2005). Well besides, other factors such as high spending on the military, and the impact of external debts on the sectors in ability to generate new investments, there are also product related problems such as the workability of alternative sources of energy

 Thirdly financial cost of installing an alternative energy system in place appears to be the biggest obstacle in Cameroon’s energy sector, the cost of say solar or wind which are all good resources for energy in the country proves to be too expensive for isolated unemployed communities. This is because the technology of conversion of solar resources is not yet available on a large scale in Cameroon, and so understanding such a project means bringing in foreign expatriates who are already versed with the field. Again we see how important List’s theory of productive power comes in. Though the solar project now looks very expensive, now especially for a developing country like Cameroon, maybe in the next few years, the cost would reduce considerably and we can begin seeing solar energy being developed on a commercial scale in the northern region of Cameroon.

To end up, the thesis has been an effort to contribute to our understanding of why a country like Cameroon should finds itself in a in an energy crisis, when there are enormous unexploited energy potentials in Cameroon such as hydro, wind and solar. Based on the fact that despite the privatisation of the electricity sector in Cameroon, there is still shortages in the country as a whole, government may think of combining a power mix for the future.

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