

EN 310 E  
Master Thesis in Energy Management

**Clean Energy in Norway  
A Case Study for Nigerian Electricity  
Development**

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**University of Nordland**  
**Bodø Graduate School of Business**

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## **Acknowledgment**

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## **Abstract**

This thesis is about electricity development in Nigeria from Norwegian context. Since Nigerian electricity sector is currently undergoing privatization, I investigated the policies that are put in place for the process to be achievable, looking into the electricity sector. I considered Norway as my point of investigation; I investigated on the electricity sector in Norway to see how effective and efficient it is working and the different locations of the hydropower sector.

This thesis also gives an overall knowledge on the hydro plants and prospects in Nigeria, which could be developed towards a clean energy and as well as to have a clean environment.

I also investigated on some issues that affects the Nigerian economy such as political instability, Environmental issues, mismanagement, corruption and so on, and show the ways the Nigerian government have tried to coup it as well as the factors the Nigerian government should put in place to achieve a clean energy which includes Environmental policies, communication with the public and so on are been discussed in this thesis, this thesis should be helpful for investors and decision makers in Nigeria.

## **Sammendrag**

Denne oppgaven er om elektrisitetsutvikling i Nigeria fra et norsk ståsted. Siden Nigerias elektrisitetssektor for tiden gjennomgår en privatisering, har jeg undersøkt de retningslinjer som er gitt for at prosessen skal være gjennomførbar, og sett på kraftsektoren der. Jeg tok utgangspunkt i Norge i mitt arbeid, jeg undersøkte kraftsektoren i Norge for å se hvor effektiv den fungerer ulike steder i vannkraftsektoren.

Denne oppgaven gir også generell kunnskap om vannkraftverk og prospekter i Nigeria, som kan utvikles i retning av ren energi så vel som rent miljø.

Jeg undersøkte noen problemer som påvirker den nigerianske økonomien, og diskuterte faktorer som den nigerianske regjeringen skal legge fram for å oppnå en ren energi. Oppgaven burde være nyttig for investorer og beslutningstakere i Nigeria.

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## **Glossary of Concepts**

NGO	Non Governmental Organisation.
OECD	Organisation for Economic Cooperation and Development.
NEPA	The National Electric Power Authority.
GDP	Gross Domestic Product.
U.C + D.L	Under construction and Direct licensing.
U.L + U.P	Under licensing and under production.
SHP	Small hydropower.
N.GEN	New Generation.
FMP	Federal Ministry of Power.
ICH	International Centre for Hydropower.
SKS	Salten kraftsamband.
NVE	Norges vassdrags- og energidirektorat.
NERC	Nigerian Electricity Regulatory Commission

## **Capacity Measurement**

Watt (W)	Unit for effect or output, energy per second
Kilowatt (kW)	1000 W
Megawatt (MW)	1000 kW
Gigawatt (GW)	1000 MW = 1 million kW
Terrawatt (TW)	1000 GW = 1 million MW = 1 billion kW
Kilowatt hour (kWh)	Unit for energy. One kilowatt produced or used in one hour
Megawatt hour (MGh)	1000 kW

## **Chapter 1: Introduction**

The history of electricity production in Nigeria dates back to 1896 when electricity was first produced in Lagos, fifteen years after it has been introduced in England, while the total capacity was 60 kilowatt (kW). For over 40 years, Nigeria, a country with over 150 million population has witness frequent and persistent power outages, inadequate power supply affects the country; in order words, adequate supply and distribution of electricity constitute a central development issue, and it is an engine of growth for all sectors of the economy.

The National Electric Power Authority (NEPA) has been in charge for the generation, transmission and distribution of the electricity power in Nigeria. But in the year 2000, NEPA was privatized as The Power Holding Company of Nigeria (PHCN) and it is divided into seven generation companies (GenCos), one transmission company (TransysCo), and eleven distribution companies (DisCos). Since the TransysCo is a monopoly and national company, it has expand annually in order to meet the ever-increasing demand, but the demand has been so enormous it has lead to limited access to electricity and the supply to those provided is not regular. The call for power sector reform in Nigeria is primarily as a result of inadequate electricity supply. The reform of the electricity sector is of extreme priority to the Government of Nigeria and the citizenry. The efforts made in the past have not yielded much result. The current administration has chosen privatization as a cardinal economic programme to address the problems of the power sector, meanwhile, in August 2010, the president of Nigeria, Dr Goodluck Ebele Jonathan, recently launched a new energy sector reform in Nigeria, as a reform of the previous act of 2005, its objective is to increase energy production by 5000 megawatt (MW) in the next three years as well as increase the price of energy investment returns too. The privatization will stimulate the economic activities in the country, and improve the health and wellbeing of Nigerian communities through reconstructing, privatization and liberalization. Privatization is the partial or total transfer of an enterprise from public to private ownership (Dieter, 1991). It is a reverse form of nationalization. Privatization of government operations is an attractive option, especially in developing nations where most government staff lack the competence, leadership and technical know-how to carry out major duties professionally (Jonas Okafor, 2009).

My research question is based on the previous related research work ‘Sustainable Energy Development: The Key to a Stable Nigeria’. Since there are a lot of factors that can affect the deployment of a new system of hydro energy in Nigeria, through my investigations, I will be able to see how these factors can be managed.

In Europe privatization and deregulation of Electricity has been going on over the years, while Norway followed with the Energy Act of June 1990, which was effective from January 1991 (Dieter Bio, 2000). Norway is the biggest hydropower producer in Europe; it has tradition over a 100 year ago. Over 857 hydropower stations with an output of 29,626 MW (Bogstrand, 2008) compared with Nigeria an output of 4,000 MW. For country like Norway, which has the hydropower production up to 99%, it will be natural to contribute with its knowhow, investments, systems and routines in a developing country like Nigeria that is in need for renewable energy and reliable power to the people and industry. Once a company had become private, it is expected to expanding across borders.

### **1.1: Problem statement**

The weak development and maintenance of the power system has been a crucial topic of discussion in Nigeria, the outages of power affects both individual and industries. The call for a '*Roadmap for Power Sector Reform*' by President Jonathan in August 2010 has been seen as the best approach towards stable electricity outflow.

Nigeria a country rich with mineral resources such as solar, wind, hydro, thermal energy and bio-energy but can only produce 4,000 MW of capacity for over 150 million people which is too little and insufficient for the country; in order to develop and manage these available resources, there should be equitable allocation and effective utilization and technical know-how towards the economic development of the country. Moreover, enough supply and distribution of electricity is seen as a central point for development. I am looking at the "potentials and development of hydro energy in Norway" since the country "About 2000 years ago, during the first century B.C., it was discovered that the force of moving waters can be use to ease human labour by rotating shafts and cogwheels to mills for grinding grain and sawing wood, operate hammers in the ironworks of western Europe and industrial power" (Robert and Jack, 2006: 126). Norwegian hydropower energy has been seen as the way forward to reduce the emission of carbon dioxide in the atmosphere, thus hydro energy "is the energy that moving water provides. Water is two atoms of hydrogen plus one atom of oxygen. Energy from moving waters is considered renewable energy" (Regina 2007: 394). Hydropower yields electricity in an essential special way than fossil fuels, the electricity is derived from falling waters which runs through a constructed dam, and its movement turns the turbines thereby generating electricity which is refers to as hydro electric power. Norway has renewable energy they produce electricity through hydropower and they would teach the

Nigerian government how they would be able to reach its expected production capacity of 40,000 MW by 2020. Norway has hydropower stations in all the 19 counties in equivalent to Nigerian States and in several municipalities in equivalent to Nigerian Local Government Areas which generates 29,626 MW and also generates 431 MW of wind power from 18 plants and 200 wind turbines in 9 counties in 2009, the development of the wind power generates 2.3 MW but only 0.3 is taken out of production. Also no new thermal was installed in 2009 but there are a total of 900 MW, which has been installed in 13 counties. Moreover, two gas reserve power turbines are installed in the mid-Norway, which generates 300 MW capacities. From history hydro energy has been a form of energy before the discovering of the fossil energy and currently about 15% of the world's electricity comes from hydro energy. This guides us to the next topic, which is the research question.

### **1.2: Research question**

The energy sector reform in Nigeria has been seen as the way forward towards economic growth and development in Nigeria, but the mismanagement of funds and unstable policy implementation has been the way the country exists. This research seeks to provide findings to address the following research question:

*“How could Norwegian clean energy technology be implemented in Nigeria and what are the implications”?*

### **1.3: Structure of the thesis**

This thesis is divided into eight chapters. The first chapter gives details of the problem statement, while the second chapter defines the methodology; describing my qualitative research process in analysing documents and interviews that I have conducted. In the third chapter, I will define privatization theories and economic growth theories. I will go ahead with background chapters for the understanding of my analysis of the Norwegian electricity sector and various resources in Nigeria that could be developed towards renewable energy; description of the electricity market in Norway as relate to Nigeria. Further on, in chapter six I will discuss the prospect of hydropower and the activities that surrounds it, before ending the thesis with the analysis in chapter seven and conclusion in chapter eight.

## **Chapter 2: Theory**

### **2.1: Introduction**

The electricity supply industry is made up of four activities, which are generation, transmission, distribution and consumption. The theories obtained here are used in analysing the empirical data. I also identify what could bring about a barrier for the clean energy implementation in Nigeria but I did not come up with a complete solution on how these obstacles could be overcome but it could be for later studies. In order to identify more understanding about my topic, I needed more theory to help me. After a very long search on the right theory such as competitive advantage theory, resource depletion theory, and ecological economics and environmental theory, I decided to use these under-listed theories:

1. Privatization theory
2. Economic growth theory

The reason I used these two theories is because free market anarchism by Murray Rothbard, an economist, who advocates that society should be based on voluntary trade (Privatization) and The neoclassical growth model by Robert Solow and Trevor Winchester swan, they advocates that countries can overcome its steady state and continue growing by inventing new technology. This theory could describe the situation in Nigeria and Norway.

### **2.2: Privatization theory**

Murray Rothbard (1926-1995) an economist who advocates that society should be based on voluntary trade (privatization). The use of privatization theory is to understand the way it can contribute to the economic growth of Nigeria, since it is believed that it promotes greater efficiency and higher output, especially in high and middle-income countries, when its likely to increase the gap between rich and poor, due to the fact that privatized assets are in the hands of small groups of local and International elites (Michael et.,al 2006). It also provides conditions under which all of the government's objectives can be attained by an appropriately designed auction of rights to produce a given product and services (Dieter Bio, 2000). In a situation whereby an option have been used to solve a problem like in the case of power failure in Nigeria;

whereby several small private companies provides power generating sets for electricity and it is approximately 60 million Nigerians use this form of alternative electricity. The privatization theory would help me to see if public-private partnerships (PPP) would be an option to remedy the problem or not. When I think about privatization of public sector, I also consider the situation in Nigeria whereby public official bureaucrats and the locals facing foreign companies' initiatives would be a problem since; there is no time or duration conscious for projects in developing countries. PPP is seen as a wide variety of arrangements involving the public and private sectors working together in some ways. It has a contractual arrangement where the parties share rights and responsibilities during their duration of the contract. It could be in form of so-called BOT (build, operate and transfer), DBFO (design, build, finance and operate) and BOO (build, own and operate) contracts. Over the years, the solution to electricity failures leads to poor services. It is increasing accepted that private producers tend to offer more cost-efficient than publicly owned ones, provided it is been regulated adequately and under competition.

#### *2.2.1: Public-private partnerships (PPP)*

PPPs is not privatization, the previous is involve in a continuous role for the public sector as a partner while the latter is involve in the total transfer of a previously publicly owned asset to the private sector. It has different forms, which are listed below:

- User-fee public-private partnership
- Availability-based public-private partnership

In user-fee public-private partnership, the government awards private parties the whole right to design, build, maintain, operates and finance an existing asset owned by the public sector. It could be a fixed contract of 30 years with a concession agreement, and afterwards will be returned back to the government. In other words, the competence and autonomy of a regulator or of a monitoring entity, where it is required, are crucial features of these forms of PPP. The private investors recoup their investments by charging the members of the public that are using their services since the risk of demand is allocated to the private companies. The tariff payment is always a concession agreement and it is regulated.

While in the availability-based public-private partnership, it has some similarities with user-fee in its method of designing, financing, building or rebuilding and operating and maintenance of the public assets. But the main difference here is that the government makes payment to the private investors as long as the service they are providing is available to the general public, in other words

the government sets the demand risk and pays the private investors for their services. In electricity sector, the availability-based PPP has been in operation, whereby the independent power producer (IPP) has a power purchase agreement with the government. They (IPP) establish a power generation plant and sell the electricity generated to a government owned power station or to a private distribution company. In this situation the government distribute the service to the public while they have a '*take-or-pay contract*'. But the decision to use any of the following options is based on the government policy towards privatization.

For effective privatization to take place, it is more successful to inform the public such as the civil servants, labour unions, political parties, potential investors, managers of public owned enterprises, business leaders, the end-users (consumers) and as well as the national and international civil society organization, and non-governmental organizations (NGO) about the prospects and benefit of the new program. To engage all these stakeholders in the privatization program has a very long positive output. First, it will always show the state of mind of the society, to see those that are in support of and against the program and the reasons behind it. Secondly, it could supply check and feedbacks from the society from inception down to the life span of the project, with these communications from the society; there would not be failure in investing in privatization. Table 1 shows the problems associated with privatization in Sub-Saharan Africa.

<b>Table 1. Top Five Constraints to Privatization in Sub-Saharan Africa<sup>@16@</sup></b>		
<b>Constraint</b>	<b>Causes</b>	<b>Effects</b>
<b>Lack of consensus</b>	Lack of information	Weak government commitment
	Lack of political will	Slow process
	Ideological beliefs	Reluctance to sell enterprises
	Vested interests	
<b>Political uncertainty</b>	History setting	Tardiness
	Democratization	Investor uncertainty



Forthcoming elections		
<b>Inadequate management capacity</b>	Weak institutional and human resources capacity	Lack of transparency
	Lack of commitment	Distrust of valuation methods
	Fragmentation	Poor design and preparation
		Incomplete transactions
<b>Legal constraints</b>	Old legislation	Insufficient authority given to agency
	Lack of commitment	Slow process
	Weak judicial system	
<b>Lack of program ownership</b>	Institutional jealousies	Lack of consensus
	Government interference	Perception of program as driven by external agencies
	Indigenous private sector donor driven	

### 2.2.2: Transparency

For privatization to be stable and without corruption, it must be mannered with transparency and integrity, which means that there are no hidden agendas, information are available for verifications, and available information for cooperation, collaboration and any further decision making. In privatization, transparency is so important if government wants to improve and to have a better result. “Building transparency into the privatization process should be a top priority for all

policymakers undertaking the effort.” In other words it is the main requirement that gives all prospective investors the same information while the privatization process is going on. But in a situation whereby the highest bidder is inexperienced while the lowest bidder is experienced in the proposed investment, and the lowest bidder is selected, in this case there is no true transparency but applying a good communication to increase transparency process would go a long way to reducing any opposing groups and political risks too. The public should not be neglected; there should be a certain level of trust towards the companies that are undertaking the certain investment. “Communication can pave the path for two-way dialog on contentious issues, so people’s concerns and misconceptions are addressed promptly before public confidence and trust are eroded” (Daniele et.,al, 2008).

To gain a good communication in privatization, it involves a good research and analysis, corresponding across all public sectors, government ministries and different organizations, it should also be integrated into all forms of the government overall economic reform. During privatization, government should ensure that the companies that are invited for bidding could ensure high-quality, technical expertise that will also help the government to have a very well planned strategy.

### **2.3: Economic growth theory**

The neoclassical growth model by Robert Solow and Trevor Winchester Swan (Robert and Barbara, 2009), they advocates that countries can overcome its steady state and continue growing by inventing new technology, it is also based on Robert Solow’s model on economic growth; which shows that increase in inputs (land, labour, capital and entrepreneur) and technical improvement determines the extent of economic growth. “The study of economic growth across nations and over time- asks whether we produce more because we employ more inputs, or whether the inputs become more productive over time or both” (Burda, 2005:47), it also refers to the expansion of the country’s GDP in a long period of time. ”The Harrod-Domar theory of economic growth, states that the rate of growth of GDP is determined jointly by the national saving and the national capital-output ratio” (Micheal P., 2006:105). There is several *stylized fact* about economic growth according to Nicholas Kaldor (1961), but there are some standards that can be observed if we are discussing about economic growth:

- Population growth

- Technological progress
- Capital accumulation

### *2.3.1: Population growth, technological progress and capital accumulation*

When more people are at work, the labour input grows steadily, since they will contribute towards more working hours. And any increase in labour inputs contributes to a marginal increase in the source of economic growth. For economic growth to be viable there should be a steady state whereby investment should not only pay off capital depreciation but it should involve labour growth in as much as it provides new workers with new or the same technology. New investment is a key progress towards population growth because at the long run, the new investment would be upgraded and improved as well as its services and qualities while new designs can be introduced to expand the quantity of these resources, which would lead to an increase in the economic growth of the country. While in technological progress, all factors of production benefits from it. It involves the development research of new product or service and in the long run it would be applied in all sector of the economy. Therefore it could be called the input towards better economic conditions. “Technological progress results from new and improved ways of accomplishing traditional tasks such as growing crops, making clothing, cooking food or building a house” (Michael P., 2006:99). The capital accumulation standard helps me to understand that some proportion of the countries present revenue would be saved and invested in other to supplement future income and outputs. In a society, the existence of new factories, machineries, materials and equipment shows that the country’s physical capital stock is on the increase; its often refers to as economic and social infrastructure which includes roads, electricity and clean water as well as digital communication. Human resources investment is another way of looking at capital accumulation; it shows that human resources can develop its qualities by giving out more powerful effects on outputs since the total number of labour has increased over the years. It could be to have an on-job training program, electrification of a school building, investments in knowledgeable materials and as well as machines and technology. “The concept of investment in human resources and the creation of human capital is therefore analogous to that of improving the quality and thus the productivity of existing land resources through strategic investments” (Michael, 2006:97). A lot of investments could be seen as capital accumulation and it has been mentioned earlier but again new resources or technologies that leads to trade-off between present and future consumption could also been seen as a capital accumulation.

## **2.4: Summary**

In this chapter I have discussed my theories, the privatization theory and the economic growth theory. It is believed that privatization promotes greater efficiency and higher output, especially in high and middle-income countries since; it is expected to increase the gap between rich and poor, due to the fact that privatized assets would be in the hands of small groups of local and international companies. It could be inform of a contractual arrangement where the parties share rights and responsibilities during their duration of the contract or as a BOT (build, operate and transfer), DBFO (design, build, finance and operate) and BOO (build, own and operate) contracts where the PPP plays a major role. Moreover, the introduction of new technologies, with effects on capital accumulation, which would lead to an increase in population way of life, which would result to an economic growth of the society through an increase in investment, has been the base of my theory in this chapter. This theory would be a guide to understand my findings during my interviews analysing, all my interviews and my data collection helped me to understand if the theory can been implemented.

### **Chapter 3: Methodology**

The choice of doing a research and the method to use is important in order to create a valuable link between the problem statement, literature, analysis and conclusion (Hellevik, 1999). The science of the society has been introduced during the eighteenth and nineteenth century, according to Saint Simon (1760-1825), Auguste Comte (1798-1857) and Herbert Spencer (1820-1903) (Silverman, 2010), which shows that a general understanding of the society is possible and desirable, it also show us how to understand and develop abilities in argumentation and logical reasoning, the ontology and epistemology are empirical in this case study. The problem statement,

*“How could Norwegian clean energy technology be implemented in Nigeria and what are the implications”?*

would be discussed in regards to the tools and methods of this research, the philosophical background would be described as well as explaining the reason for choosing the research design. The sources of data as well as the techniques I used in collecting them are detailed so that the reader can understand the purpose of the research. The question about the research reliability and validity would be address after stating my means of primary and secondary analysis.

#### **3.1: Introduction**

This is a description of process towards my research topic. The word ‘method’ is derived from the Greek word ‘methodos’, which means ‘to ‘hodos’’, which is the road to a goal. Methodology is the way a method is been used and it involves the use of rules and frameworks. It could be defined as “the systematic study of methods that are, can be or have been applied within a discipline” (Merriam-webster) in other words I could say that methodology shows the way I collect, systemize, analyse and interpret my data. This chapter shows how I intend to collect data, and the approach I used in analysing the data I collected from my empirical primary sources of data, which are investors, public authorities, and citizens, and my secondary sources which includes textbooks, journal articles, and websites published and unpublished materials. The interpretation of all my data is based on different economic situation of Nigeria and Norway and the way people view different projects or activities of the government.

### 3.2: Methodological Approach

The approach I use to identify the area of interest in my data collection and analyses is based on the way things have been going on in Nigeria. The results I got could be under investigation, since there is possibility of social change in a given situation. Social change “refers to an alteration in the social order of a social group or society; a change in the nature, social institutions, social behaviors or social relations of a society” (Wikipedia).

I believe in the social constructivism view, which helps me to understand the way people make sense of the world especially through sharing their experiences with others via the medium of language or service. In my research, I try to understand the two different societies and see how people view new ideas. I want to use previous studies on related topic and evaluate the current situation in Nigeria and to see how prepared the private electricity-generator set sellers will welcome the new hydro companies and the privatization process as a whole. The private electricity-generator sellers would lose the profit from their return on investment since there could be a constant power supply in Nigeria, this could be a major barrier towards implementation of the project. My research question is based on the previous related research works ‘*Sustainable Energy Development: The Key to a Stable Nigeria*’ by Uduma and Arciszewski (2010). Since there are a lot of factors that can affect the deployment of a new system of hydro energy in Nigeria, through my investigations, I will be able to see how these factors can be managed and improve.

The next step I considered in my methodology process was the research design that would be very suitable for my investigation; I chose the qualitative design method other than the quantitative method. Since qualitative methods involves collecting data that is mainly in the form of words, and quantitative methods involves data which is either in the form of words, or can be expressed as in numbers (Easterby-Smith et al., 2010), apart from data sampling, the most commonly used method in quantitative research is questionnaires while in qualitative research, interviews is the most commonly way of collecting data, also quantitative research is based on theories which comes from qualitative research. After going through some research textbooks, I have listed below differences between qualitative and quantitative research, see Table 2:

**Table 2:      Difference between qualitative and quantitative research**

Qualitative Research	Quantitative Research
Small sampling	Large sampling
Social constructionism	Positivism
Understanding of the data	Cause and effects
Developing theory	Testing theory
Closeness to data been studied	Distance from data been studied
Circular process	Direct process
Interpretation	Statistical analysis
Observation, interviews and review of documents	Questionnaires and survey
Background dependent results	Generalizing results

From the table above, quantitative research mainly focus on the numbers and generalizing results in parts while the qualitative research has a continual process.



**Figure 1. Qualitative process**

Also the openness to the research question gives the interviewee/respondent a feeling of closeness in expressing their views and contradictions. Qualitative research is also flexible; the problem statement can be changed since it explores attitudes, behaviour and experiences through such methods as interviews and focus groups. It also attempts to get an in-depth opinion from participants about the problem statement.

### **3.3: Methodological description**

Qualitative research is a study that often involves description, though of course for different purposes from those of experimental research (Hart, 2005). The purpose of a qualitative method is to explore why Nigeria is interesting in Norwegian clean energy and to understand if the Norwegian technology can be applied in Nigeria too. It shows information also from a particular study of interest and also tells a story of a given situation. There are a lot of qualitative research designs and anyone I choose will enable me to understand the way to approach my data collection and analysing it too. Easterby-Smith et al. (2008) states that there is quite a wide range of methodologies which fit within the constructionist paradigms such as:

- Action research and cooperative inquiry
- Ethnography
- Narrative methods
- Case study
- Grounded theory

To understand the differences between these social science research design, I will state their purposes with its common understanding, in action research and cooperative inquiry, the researcher is seen to be part of the process change occurring in the society, while in ethnography, the researcher should be able to understand the breakdown knowledge of a situation, he or she should be able to be part of the study in order to understand the whole meaning of individual behaviours. In the narrative methods, the researcher should be able to understand the stories and myths associated to a given situation. While in case study, the researcher would be able to look in depth in different forms of situations either in an organization or society. The last one is the grounded theory; here the researcher should be able to evaluate a situation from different angle.



After going all through this social science research designs, I found out that the most suitable one for me is the case study. A case study would help me to gain new phenomenon, since it is an example of an intensive design, which helps me to study the different cases in depth to be able to understand it much better. “Case study is a strategy for doing research, which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence” (Flyvbjerg, 2006). To understand more about case study, I applied the Yin approach, Yin (2003) states that a multiple case study can very well mix primary and secondary data and that data does not need to include direct, detailed observations as a sources of evident. According to Yin (2003), there are three types of case studies:

- Exploratory
- Explanatory
- Descriptive

An exploratory research study is seen as groundwork to a bigger research project, it is so interesting because fieldwork and data collection can be done before the research question is defined. Whenever a case study that would be observes is more than one or two, and its variables can influence the outcome, the explanatory research study is been used. While the descriptive research helps to build the research study with suggestion from realities, from which a problem statement is defined.

In my research work I am applying the exploratory case study. The exploratory case study would help me to understand the nature of the problem, which would present an approach to a new idea during the investigation, the use of exploratory research is used when problems are in a preliminary stage and most data collections are from the secondary data, it is also flexible and can address research questions such as ‘what’, ‘why’ and ‘how’ (Babbie and Earl, 1989). The exploratory strategy allows the research to realize the nature of a problem through exploration aided by proper use of questioning to ultimately see the problem differently.

### **3.4: Data collection**

To collect data for my research work, I have chosen two categories of data collection, which are primary and secondary data.

- Primary data: The data I collected here are based on individual response to the research question, it is valid and original too and they are based on one-on-one interviews, phone calls. But its main weakness is that it consumes a lot of time to collect and analyse the data too since different respondent are not available when needed.
- Secondary data: These are data I collected from newspapers, books, journals, magazines and internet search as well as previous research works that are not really related to my research work but was a guideline.

I used both the primary and secondary data collection but to perform analyses on these reports it would consume a lot of time so I selected a few interview to analyse. The secondary data collection was so helpful because I was able to study so many case studies. The research I studied were reports from government authorities and private companies. Since government organizations are not profit oriented, they always tend to protect any case they are reporting or publishing. But the private company is for profit making, but when they are affected and threaten to leave business, they will be obliged to report a clear case of report. I also got information from company reports and newspaper companies in Nigeria, they tells the story on what are the current issues in the country, but I have to analyse these reports since I know that there are a lot of bias information from the media and private companies too.

Like I said earlier I did primary interviews with entails the use of phone calls and one-on-one interviews with my interviewee, which includes:

- Bjørn Pedersen of Bodø energi.
- Jostein Fagerheim, project leader and Johnny Horsdal of Salten kraftsamband (SKS).
- Hamnaberg Håvard and Arnesen Fredrik of Norges vassdrags- og energidirektorat (NVE)
- Mrs. Kristin T. Wæringsaasen Petroleum and Commercial Affairs (Norwegian embassy in Nigeria) of Norad.
- Ayolede, private generator supplies.
- Amechi C. Alope of Nigerian Electricity Privatization staff.
- Sam Amadi member of Nigerian Electricity Regulatory Commission.

Since my interviewee/respondents were in Norway and Nigeria, they contributed their general knowledge to describe my research so I fulfil the requirement of a research design. The interview I did at the conference in Bergen at the 11th NPF North Sea Decommissioning Conference helped me to get an intensive understanding on the topic of my research work. I used more data information from the secondary data but my primary data was used to get additional information from experiences and personal beliefs and thought towards the hydro energy or clean energy and privatization in Nigeria. The primary interviews also help me to understand different ways to cooperate and communicate the different actors in the Nigeria society that would be affected after the privatization of the power sector, it also showed me a lot of suggested problem and solutions that I did not take into account before.

Moreover, during the primary interview at conference organized by the Norwegian Petroleum Society (NPF) in Bergen which I participated in, I was opportune to meet different oil and gas politicians and researchers whose ideas were a motivation towards my research work, they gave me an overview of the hydro energy performance in Norway. While I was doing my primary interview, I got to know a very resourceful person that made me to understand more the situation in Nigeria and suggested a way to resolve the problem I asked in my research question. Since my research problem was spread with a lot of issues, I was not just gathering all kinds of information but I was trying to show the situation of privatizing power sector in Nigeria. I had an open question instead of a close question so that I can get more ideas towards suggested solutions. The Nigerian government wants to invest in renewable energy, they want to solve the power problem with the society in mind but a lot of problem has been hindering this progress and if not tackled now it could affect the new wave project. So I interviewed a lot of citizens via the Internet media (group on 'Facebook') and read their view towards the on going privatization and their contribution whether it should go on and their support towards it too.

I structured my interview in a way that most questions are prepared in forehand with follow-ups; I also have a guide that I used to ask different questions so that I can touch all the different areas. I also made a point of interviewing in Norway in a familiar, natural and at the environment of my respondents. They were comfortable with me and show me a lot of slide power points on their conference room, so they did not come up with artificial answers. During the phone call interviews, I recorded the interview since my phone has a recording aid, it helped me when I was analysing my data, listening to their comments once again.

### 3.5: Data Analysis

After collecting all my data, my main aim is to understand and explain them correctly. I am using David Silverman's method of data analysis (2010). He divided the process of qualitative analysis into four steps, which are: *describe, organize, categorize and compare*.

*Describe:* Here, I should be able to describe the situation with an objective view without been sentimental or judgmental too. I looked at the situation of electricity in Norway and describe what is going on in the sector and how effective the current situation works.

*Organize:* I should able to look at a process within these data, if there are similarities or differences within the data collected. I also organized the process and to see if there is any similarities if compared to Nigeria.

*Categorize:* To categorize a data is to narrow it down to one part of a process. I categorized the use of hydro energy instead of looking at the broad view of any alternative renewable energy. I narrowed it down to different categories.

*Compare:* It very important to find cases that is similar and compares them. I also compared if Norway has a major hydro energy or they are divided into different small hydro energy in different cities.

After I collected all the data, it was time consuming to analyse it but with the help of my respondent responses, I was able to categorized it and analyse the results. More of the analyses will be discuss in chapter seven.

During the description of my data, some of the recorded interviews are unprocessed data, because most interviews lasted more than 2 hours except the phone call interviews, when transcribing the data, it takes several hours and a lot of text so I made some bullets points with little description of the text to understand the view of my respondent and place it in the right category. I had to rework the data I collected so that I can understand and place it description on the right category.

I organise and categorize my data, in the sense that each category has its theme, see Table 3:

**Table 3: Different categories for data analyses**

<b>Category 1</b>	<b>Authority / Agencies</b>
<b>A</b>	NVE in Norway
<b>B</b>	BPE / NERC in Nigeria
<b>Category 2</b>	<b>Investors</b>
<b>A</b>	SKS / Bodø energi in Norway
<b>B</b>	Proposed Investors in Nigeria (NORAD)
<b>Category 3</b>	<b>Citizens</b>
<b>A</b>	Norwegians
<b>B</b>	Nigerians

This work helps to simplify the analysis, statement from my respondents are easily compared, the categories are decided from the interviews. The themes that contain the same idea belong to the same category. Qualitative research instructs the researcher to be open-minded, so I control the category to achieve validity in my report. This category should give relevance and meaning to people outside the research.

During the combination, after categorising my respondents, I made a connection between information in the different category; the information I connected was from secondary data to understand the validity of my respondent views.

### **3.6: Validity and reliability**

Validity is another word for truth (Silverman, 2010); validity can be measured in two different aspects: internal and external validity. In each of these aspects it would be effective to measure the results and see how similar it could be if measured over and over again. Internal validity shows the confidence that the findings and results I produced in my study are true. By taking a long study on different cases, by discussing my findings, methods and results with my supervisor, it appears that my objective interpretation and the open ending to my research work gives the research work an internal validity. The case I choose and the selection is not so broad as compared to Nigeria but

my respondent were so willing to give me the best of their knowledge towards hydro energy in Norway, and I also consider it as a valid report.

External validity shows how widely a result can be used and accepted. The results could be implemented in a similar situation. Qualitative research work does not encourage generalization but an in-depth view of the situation so the transferability of the result would be focused on general, common findings with the same circumstances. This research is not generalizing its findings but it is a way forward towards understanding the best possible way to tackle the current situation in Nigeria since the same results from Norway can be implemented.

Reliability shows if the choice of methods and theories could affect the results of my thesis. The data I collected in relation with the theories I used here has enhanced the reliability of my results. In privatization theory I explained here shows different forms of privatization, which is possible to use as a gateway towards development, while in economic growth theory, it indicates that Population growth, Technological progress and Capital Accumulation could lead to an increase in the Gross Domestic Product (GDP) of a country. The results I got could help any foreign investors in doing business and also see the opportunities that are visible in Nigeria.

### **3.7: Limitations**

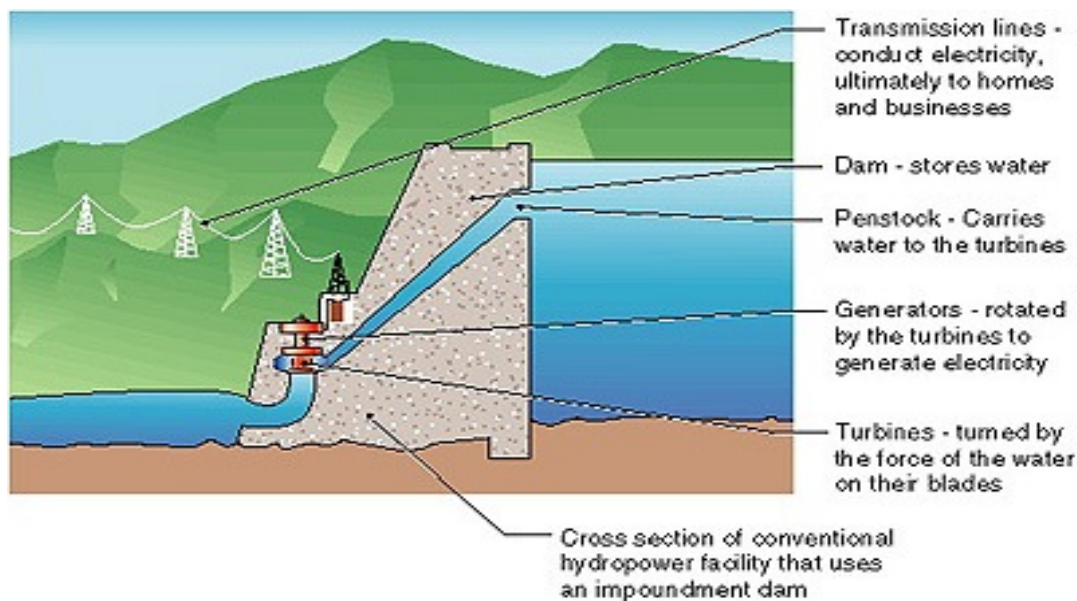
The discussion about clean energy development in Nigeria has a lot of aspects. My thesis will have some limitations in this context. My goal is to evaluate the possibility of clean energy in Nigeria and its benefits to the society. I will also touch on the possible conflicts among different actors in the society and show the quality of services that Norwegian companies would be offering, due to insufficient time factor, I will not recommend all the possible solutions but it could be for further studies.

## **Chapter 4: Empirical data**

The empirical data was collected from my secondary data but will be analysed with the primary data during the analysing process, in this chapter; I started with an introduction of hydropower and its different types, its advantages and disadvantages, I looked briefly into the hydropower capacities and potentials, grids and electricity market in Norway. I also consider the sources of electricity and its challenges in Nigeria as well as the prospects and government policies in implementation of the projects. The prices, risks and hedging was the lastly discuss briefly.

### **4.1: Introduction**

“About 2000 years ago, during the first century B.C., it was discovered that the force of moving waters can be use to ease human labor by rotating shafts and cogwheels to mills for grinding grain and sawing wood, operate hammers in the ironworks of western Europe and industrial power.” (Robert and Jack, 2006:126). Renewable energy has been seen as the way forward to reduce the emission of carbon dioxide in the atmosphere, thus hydro energy “is the energy that moving water provides. It is so called because water is two atoms of hydrogen plus one atom of oxygen. Energy from moving waters is considered renewable energy” (Regina, 2007:394). Hydro energy or waterpower has been considered as a renewable form of energy and it is the main renewable energy used around the world. It yields electricity in an essential special way than fossil fuels, the electricity is derived from falling waters which runs through a constructed dam its movement turns the turbines thereby generating electricity which is refers to as hydro electric power, see figure 2:



**Figure 2: The process how Hydropower plant works**

The future outlook shows that petroleum would become scarcer and the world would need a form of renewable energy to replace the energy security; hydroelectric power could be the next alternative form of energy since it is clean, renewable and mostly can be seen around the world. From history hydro energy has been a form of energy before the discovering of the fossil energy and currently about 15% of the world's electricity comes from hydro energy. Also the advancement in technology would be an added advantage since it would increase the role of energy to meet the global security of energy.

#### *4.1.1 Types of Hydropower*

There are three types of hydroelectric power plants:

- Micro-scale hydroelectric which is used mainly in small villages and towns in the developing countries since it could be managed and operated by small scale machineries. It can produce up to 100 kW.
- Small-scale hydroelectric. This form of plant can produce up to 20 MW of energy and it is seen in developing countries too.



- Run-of-the-river hydroelectric power plant is situated at the top of the river since it has a good elevation for waterfall or a diversion could be an option. There is no need for a dam or reservoir construction, and it could provide from 30 MW.

The run-of-the-river hydroelectric energy is the best form of electricity provider since it does not need the construction of a dam; which is very expensive if a big dam should be constructed and also the environmental effects of flooding during the construction of dams see figure 3:



**Figures 3: Diversion Dam. A form of diversion hydroelectricity plant in Alaska**

Since hydroelectricity is a main form of renewable energy, I have stated below the advantages and also its disadvantages of usage and production according to Itaipu Binacional at the Top World Conference on Sustainable Development, in Johannesburg and at the 3<sup>rd</sup> World Forum on Water, in Kyoto in 2002 and 2003 respectively:

Advantages and disadvantages of hydropower

- Hydroelectricity means clean and cheap energy for today and for tomorrow.
- Hydroelectricity promotes guaranteed energy and price stability.
- Hydroelectricity is a renewable energy source.
- Hydroelectricity contributes to the storage of drinking water.
- Hydroelectricity makes it feasible to utilize other renewable sources.
- Hydroelectricity increases the stability and reliability of electricity system.

- Hydroelectricity helps fight climate change.
- Hydroelectricity improves the air we breathe since it does not emitted pollution.
- Hydroelectricity offers a significant contribution to development.
- Hydroelectricity is a fundamental instrument for sustainable development.

While its disadvantages are as follows:
















- Dams affect the fishes and other aquatic species.
- Reservoirs construction displaces people; destroy vegetation and habitat of animals.

(Diane Raines, 2002)

From this point, we could see that hydroelectric power has a lot of advantages if compared with the conventional fossil fuel plants. Its life span is for many decades from 50 to 200 years and it seems that a little maintenance is needed in operating the power plant. The concept is quite simple, “water turns a turbine, the turbine spins a generator, and electricity comes out the other side” (Dannew. 2005:34).

**Table 4: Ten of the largest hydroelectric capacity**

**Ten of the largest hydroelectric producers as at 2009.**

<b>Country</b> 	<b>Annual hydroelectric production (TWh)</b> 	<b>Installed capacity (GW)</b> 	<b>Capacity factor</b> 	<b>% of total capacity</b> 
 China	652.05	196.79	0.37	22.25
 Canada	369.5	88.974	0.59	61.12
 Brazil	363.8	69.080	0.56	85.56
 United States	250.6	79.511	0.42	5.74
 Russia	167.0	45.000	0.42	17.64
 Norway	140.5	27.528	0.49	98.25
 India	115.6	33.600	0.43	15.80
 Venezuela	85.96	14.622	0.67	69.20
 Japan	69.2	27.229	0.37	7.21
 Sweden	65.5	16.209	0.46	44.34

From this table, Norway has the highest percentage of the total capacity of hydro production; it includes lakes, snowfields, and glaciers. In the next page, I would look into the potentials of hydropower in Norway.

#### **4.2: Hydropower potential in Norway**

From the data in Table 4; we can see that Norway is the 6<sup>th</sup> largest producer of hydroelectric power, following China, Canada, Brazil, USA and as well as Russia. Norway is the biggest hydropower producer in Europe and it has over 100 years of tradition and their power station all over the country is estimated to be 857 hydropower stations which include 330 large dams and small dams (Bogstrand, 2008). Over 98% of the power generated in Norway comes from hydroelectric plants with the recent generating plants from wind energy, thermal and marine energy. The electricity in Norway is used for cooking, lighting, all form house electrical appliances and as well as heating the houses. Norway has developed better high competence in hydropower and it covers all aspects from planning, installation of technical equipment and delivery of electricity as well as well organizes regulation and administration.

##### *4.2.1: Types of Dam*

They have different forms of advanced technologies from reservoirs to dams;

- Embankment dams, this is constructed as an artificial water barrier or stone mass in different zones. This dam is built with concrete or asphalt filled up with different composition of soil, sand clay or rocks and a waterproof covering for its surface, see figure 4:



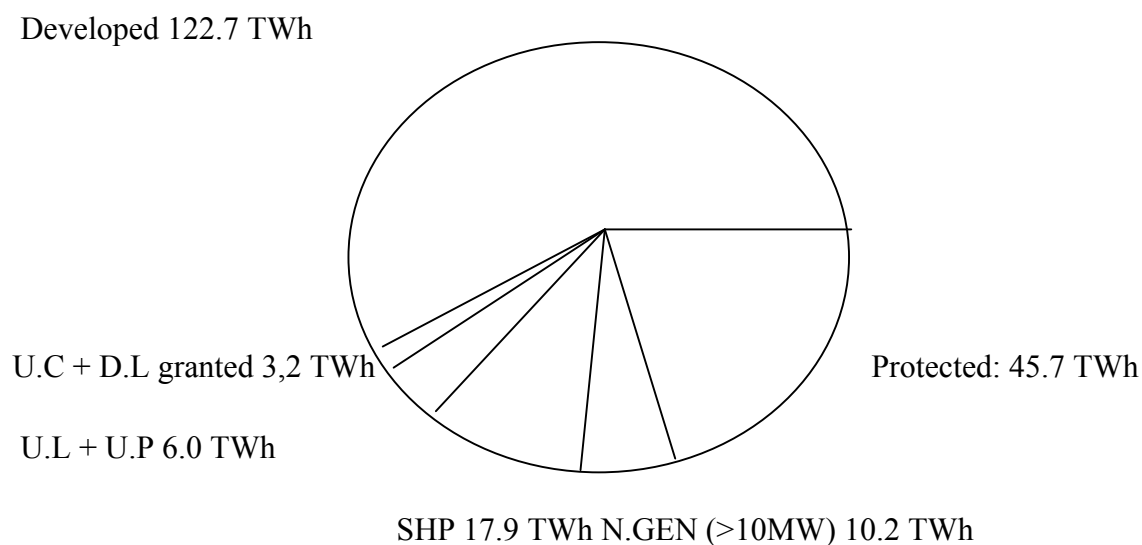
**Figure 4: Embankment Dam**

- Concrete dams, this type of dam has different forms depending on the type of topography of the area. The different types are gravity, plate and arch dams.
1. Gravity dam, this form of dam is also called the solid dam; it requires maximum amounts of concrete for its construction and it resists dislocation because of the hydrostatic pressure of reservoir water by complete weight. Since it requires a lot of concrete, there should be a complete aggregate for producers of concrete, see figure 5.
  2. Plate dams' transfers' structural weight through pillars.
  3. Arch dams, this type of dams are placed in narrow valleys so that the water pressure from upstream is transferred through the vaults to the rock in the direction of the sides, see figure 5.



**Figures 5: Gravity dam (to the left) and arch dam (to the right)**

The use of better computer tools have led to a better and more systematic way for controlling, monitoring and operational simulation of the hydropower plant since most of it is controlled by remote control and it has lead to reduction in its operational cost. Small hydropower plants are constructed all over the country. Norway's hydropower potential is seen as the amount of energy that comes from its rivers and its ability to generate electricity technically and financially and it was calculated to be 205 terawatt hours (TWh) per year as at 1 January 2008 and this calculation is based on the inflows periods from 1997-1999 (Björg, 2008: 24).



**Figure 6: Hydro potential in 2008 (mean annual production)**

From the pie chart above, 122.7 TWh per year of hydro production is developed, some projects with a capacity 3.2 TWh is in the process of development but has been granted while in 2007, the Norwegian government issued licenses for 57 small hydropower stations and it has a total production estimated to 17.9 TWh per year. Also these licenses were increased by four hydropower projects that could generate additional 140 GWh per year and it was granted by the royal decree. Also in the same year 2007, according to the Ministry, 58 mini and micro power stations estimated to provide 85 GWh per year was granted. So the total hydropower potentials approved by the energy authorities were 1.2 TWh in 2007. There is a Master Plan that guides the water resources and this master plan directs how the hydropower should be developed; from the lowest cost to the projects that have very little conflicts of interest.

To build an infrastructure needs maintenance and refurbishment, in Norway, hydropower stations are refurbished and modernized to use more of the potential energy of the water flows, with this



system, the operational cost and reliability of the hydropower stations are low and certain. It is also the initiative of the developer to find new projects to maximize the water flow heads and they also bear the risks involve. The expertise that Norway can offer has gone a long way from planning and designs to the delivery and installation of technical equipment's in all the hydropower stations. Hydropower stations in Norway has been managed and regulated by the authorities and different power companies. The International Centre for Hydropower (ICH), which was established over 15 years ago, has their main objective to share the unique expertise from the Norwegian hydropower sector. ICH is the gathering of all power companies, authorities and suppliers that are involve in the generation and distribution of the electricity power supply. Its head office is located at the Norwegian University of Science and Technology (NTNU) in Trondheim; it gets most of its grants from Norad.

The knowledge from Norway through the Norwegian Water Resources and Energy Directorate (NVE) in hydropower has gone beyond the European countries to some developing countries; they assist the developing countries in any energy and water resources related issues, cost and quality control of projects and different lectures programmes. Below are some countries that NVE has been involved with Norad, see figure 7.



**Figure 7: Countries that are involved with NVE and Norad**

### 4.3 Hydropower production in Norway

Norway has more than 100 years of experience with hydropower; it is also the highest producer of electricity in Europe from hydropower (Petroleum and Energy Department). Production of electricity takes place in different European countries, 141 in Norway, 59 in Sweden, 11 in Germany, 4 in Finland, 3 in UK and 15 been produced outside Europe, total of 233 hydropower plants. The 141-hydropower plants in Norway are also divided into large and small hydropower projects. Norway has advanced in its production and consumption of hydropower electricity, since electricity cannot be stored; there is always a balance between production and consumption, it is based on imports and exports of electricity that were generated while the production is generated by mostly companies owned by different municipalities as *States in Nigeria*) and counties as Local Government Areas in Nigeria or a combination of both (NVE). Most power plants can store water in reservoirs because in Norway during the winter period, the water flow reduces and the demand for electricity is very high because of the need for heating due to the cold weather, so water can be released back to the station. For any production to take place in either the municipalities or the county, there is Energy act, Local area licenses, and also a Trading license. According to Bogstrand (2008), “The Energy Act involves the regulation of any hydropower construction, operation, district heating system, electricity trading, control of monopoly operations, foreign trade in power, metering, settlements and invoicing, the physical market for trade in power, system coordination, rationing, electrify supply quality, energy planning and contingency planning for power supplies. While the Local area Licenses involves the construction of lines and electricity distribution installations carrying a voltage of 22 kV or less”. Also the Trading License is important for the market-based power trading system through the Grids which are monopoly in nature; also it provides the authority to regulate grid management and operation”. The reason for all these licenses is to ensure that installation and operation of all kinds of hydropower will have a consistent standard. The local municipalities and county authorities own around 52 per cent of the Norwegian power generating capacity, while the Central government, through Statkraft SF owns around 36 per cent while the remaining 12 per cents are owned by private companies. The private companies operates in all sector of the electricity production which includes generation, transmission and trading. Table 5 is listing hydropower production by counties in Norway.

**Table 5. Hydropower production from NVE facts 2008**

<b>County</b>	<b>Status 2008</b>				<b>Additional 2009 End of 2008</b>	
<i>County</i>	<b>Total capacity (MW)</b>	<b>Mean year generation (GWh)</b>	<b>Total capacity (MW)</b>	<b>Mean year generation (GWh)</b>	<b>Total capacity (MW)</b>	<b>Mean year generation (GWh)</b>
<i>Østfold</i>	801	4,118	20	50	821	4,168
<i>Akershus</i>	183	925	-	-	183	925
<i>Oslo</i>	5	22	-	-	5	22
<i>Hedmark</i>	532	2,402	-	-	432	2,402
<i>Oppland</i>	1,526	5,895	6	27	1,532	5,922
<i>Buskerud</i>	1,924	8,383	5	20	1,929	8,404
<i>Vestfold</i>	4	16	-	-	4	16
<i>Telemark</i>	2,561	11,334	-	-	2,561	11,334
<i>Aust-Agder</i>	1,170	4,453	2	3	1,172	4,456
<i>Vest-Agder</i>	2,072	9,402	2	10	2,074	9,412
<i>Rogaland</i>	3,530	12,107	14	262	3,544	12,369
<i>Hordaland</i>	4,125	16,394	19	67	4,144	16,461
<i>Sogn og Fjordane</i>	3,789	14,123	23	83	3,813	14,205
<i>Møre og Romsdal</i>	1,357	6,485	8	26	1,365	6,511
<i>Sør-Trøndelag</i>	1,053	4,548	3	9	1,055	4,557
<i>Nord-Trøndelag</i>	718	3,192	10	34	728	3,226
<i>Nordland</i>	3,226	14,771	14	49	3,280	14,820
<i>Troms</i>	570	2,665	-	27	570	2,692
<i>Finnmark</i>	314	1,518	-	-	314	1,518
<i>Total</i>	29,500	122,753	126	667	29,626	123,420



Norway also generates 431 MW of wind power from 18 plants and 200 wind turbines in 9 counties in 2009, the development of the wind power generate 2.3 MW but only 0.3 is taken out of production. Also no new thermal was installed in 2009 but there are a total of 900 MW, which has been installed in 13 counties. Moreover, two gas reserve power turbines is installed in the mid-Norway which generates 300 MW capacities.

#### **4.4: Grids**

The electricity grid is a complex transportation system that combines production and consumption, it is monopolistic in nature because it is not profitable to run a separate parallel grids, but has a fixed price for all companies transporting generated power to the grid, it could be a point-to-point tariff system or a hub or market place which would involve different generating companies.

##### *4.4.1: Types of Grids*

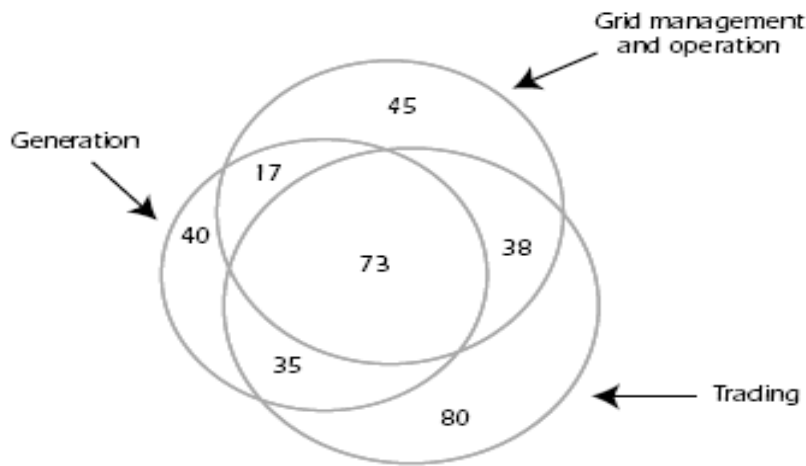
In Norway, the grids are divided into three different levels, which are central grid, regional networks and distribution networks.

- Central grid, this is the highest voltage levels, it has a capacities from 300 kilovolt (kw) to 420 kw, and it carries power over a long distance since there is no networks of network at high voltages.
- Regional network, it has a voltage from 66 kV to 132 kV and its power flows from the national grid to the local distribution network or directly to the local municipalities.
- The local distribution network distributes power to the local customers and the voltage level they distribute can be used for all electrical appliances at home or office. Like I mentioned before, the municipalities could own and operate the transmission and distribution, so they could own and operate the regional network as well as the distribution networks too. Its power voltage is from 230 V to 400 V.

Moreover, to distribute all these powers from the central grid down to the distribution networks, there is a voltage converter in all the processes, it take place in the transformer stations that connect the different networks. Many players are in the grid business in Norway but the majority of the central grid is owned and operated by Statnett, which is seemed as a state road in the Norwegian power supply.

Norway has developed a power transmission line to the neighbouring countries like Sweden, Denmark, and Finland as well as Russia and they have plans to develop more lines to the Netherlands, Great Britain and Germany. A total of 159 companies are into the grid operation, some of them are into distribution grid while others are into the regional and central grid too. The

regulation of the grids is done by the NVE and they regulate about 155 network companies in Norway.



Source: Norwegian Water Resources and Energy Directorate.

**Figure 8: Electricity participations by companies in Norway**

From the pie-chart in figure 8, most grid companies are partly or fully owned by more or one municipality but the state owns about 87 per cent of the central grid. Some companies are into generation and distribution, while some are into generation, distribution and trading too, others are into distribution and trading only. The companies that are into the three form of ownership is called vertically integrated companies and it estimated that 117 companies are engaged into activities that are subject to competition which are the generation and trading the electricity. The trading companies are involve in the buying and reselling of electricity from the market (Nord Pole), a total of 284 companies are engage in the trading business and about 96 out of it has solely the license to trade, the two largest trading companies, Statkraft Energy AS and Norsk Hydro Produksjon AS supply electricity only to industrial and commercial activities (Bogstrand, 2008).

#### **4.5: Electricity market in Norway**

The Norwegian Energy Act was passed in June 1990 but was effective from January 1991, the competition is so intense because the main aim for the market change were to improve the social economic effects, improve the efficiency and reduce the discrimination among different types of customers (Wangensteen, 2007). Before the restructuring, Statkraft was solely responsible for one third of the generating capacity, also seventy per cent of its transmission grid. It has a monopoly for the import and export of electricity power in Norway, but a lot of arguments such as equity

among consumers, reasonable geographical variations, excessive investments, and cost reduction lead to the new act to be implemented. The Ministry of Petroleum and Energy (OED) have the responsibility to arrange and coordinate the general policy, while The Norwegian Water Resources and Energy (NVE) are responsible to manage and regulate the electricity market. The new act allows all generating companies to supply electricity to the transmission grid and the tariff shows that the producers are paying a fee to the grid operators for each kWh that they dispense into the grid and consumers do not know where the electricity is coming from but they pay for each kWh they consume. There is an account that shows the amount of electricity each producer generates to the grids and the consumption rates of each consumer, the prices of electricity varies base on change in consumption, generation and transmission periods. Also the production of electricity does not correspond to the supplies to customers, which the new act, producers can always buy and sell generated power in the market and the main market is the Nord Pool. The Nord Pool Group comprises both a marketplace for physical power contracts (Nord Pool Spot AS) and a market place for purely financial contracts (Nord Pool ASA) (Bogstrand, 2008: 94). The Nord Pool's products are divided into three, which are the physical market, the financial market and clearing. Statnett assess the electricity market from different part of Norway, its assessment is based on the supply of water to the reservoirs from various regions. The markets in Norway is divided into five market areas (East, Southwest, Central, Northern and West of Norway) of power and different prices are seen in different part of the country which also depends on the demand and supply from each region. The power sector has been developing due to the increase in consumption and production of electricity, and the generating companies are spread all over since it has been under competition. There is a market-based system (Elspot) for buying and selling of power, which also address the traffic jam that occurs. Elspot is the spot market offering trade for day ahead physical delivery. Prices are determined through a double auction for each hour in the day. The system price, which is the unconstrained price in Elspot, is the reference price for financial trade in the Nordic market (Wangensteen et al., 2007), while the physical balancing of the market is done by Elbas and it is done intra-day for trading in Sweden, Finland, Denmark and Germany; it starts when the Elspot has been concluded which involves trading up to an hour before the time of delivery. The Elbas is administered by Nord Pool Finland (Bogstrand, 2008). The market of long-term electricity in Norway is called the Nord Pool which are involve in the trading and clearing of physical and financial power contracts in the Nordic region. Nord Pool was established in 1993 as an exchange for the Norwegian electricity market but it was extended in 1996 to include Sweden.

But in 2002, Nord Pool was restructured in three different ways:

- Nord Pool ASA, which has two national grids companies; Statnett SF in Norway which has 50% and Svenska Kraftnat in Sweden which also have 50%. The new EEX in Germany, Nord Pool also has 17% of their electricity power.
- Nord Pool Spot, which is the transmission between Norway, Sweden, Denmark and Finland and each of them, has a share of 20% while NordPool ASA owns the remaining 20%.
- Nordic Electricity Clearing House, which handles all the clearing and settlement activities of the electricity markets from all the Nordic countries. It is a separate entity from the two above.

#### **4.6: Summary**

In this chapter, I have shown that Norway has 141 hydropower stations and its electricity production comes from hydropower. The local municipalities and county authorities own around 52 per cent of the Norwegian power generating capacity, while the Central government, through Statkraft SF owns around 36 per cent while the remaining 12 per cents are owned by private companies. The private companies operates in all sector of the electricity production which includes generation, transmission and trading. The grids are divided into three different levels, which are central grid, regional networks and distribution networks. While the trading is done by Nord Pool, Nord Pool ASA, Nord Pool Spot, and the Nordic Electricity Clearing House; in collaboration with the Nordic countries.

## **Chapter 5: Electricity Energy in Nigeria**

### **5.1: Introduction**

In Nigeria, the Power Holding Company of Nigeria (PHCN), formerly Nigerian Electric Power Authority (NEPA) was created in 1972 and they are vertically integrated. Its electricity generation was both from hydro and thermal power; The Federal government of Nigeria (FGN) has the responsibility for policy formulation, regulation, operation and investment in the Nigerian power sector. All the regulations are done through the Federal Ministry of Power (FMP) with a monopoly operation through the NEPA; which are involve in the generation, transmission and distribution of electricity in the country. The power system has been suffering from low generating plant availability and high outages of power from the transmission and distribution networks, to handle the problem that NEPA faces with poor distribution and maintenance of electricity, the FGN in 1998 amended the prevailing law on monopoly of the sector and encourage private sector participation (PHCN 2010-2011), moreover, the FGN established the PHCN and unbundled it into 18 successor companies, in view to transfer the management and financing of the operations to the organized private sector, to have an independent and effective regulation to monitor and to oversee the industry and to have a strong policy formulation and long-term development of the industry, which could lead to a better results in electricity accessibility, increase efficiency, affordability, reliability and as well as quality electricity services and open doors to greater investment in the sector.

During the year 1999, seven out of nine power systems crumpled and it affected the production and the distribution of electric power until these days with a total production of 4,000 MW. The FGN owned the electricity system and them as follows:

- Three hydro and seven thermal generating station with a total installed capacity of 6,852 MW, with available capacity of 3,542 MW (as at 31<sup>st</sup> July 2010)
- A radial transmission grid (330 kV and 132 kV) owned and managed by the Transmission Company of Nigeria,
- Eleven distribution companies (33 kV and less) that undertakes the wires, sales billing, collection and customer care functions within their area of geographical monopoly (PHCN 2010-2011)

But access to electricity service is very low in Nigeria more than sixty per cent of the populations are not served with electricity, this is because of the asset deterioration, neglects, vandalism and theft, the low service of electricity has made Nigerian household, business and industries to resort to self power generation which has resulted to a high cost of investment in the fuelling, operation and maintenance of the generator sets. The Bureau of Public Enterprise (BPE) said above 100 million Nigerians are without electricity but depends on fuel and diesel generator sets (see figure 9) for electricity supplies which, releases toxic fumes that cause respiratory disease.



**Figure 9: Electricity generators from private generator sets from Stephen Kurczy (2010).**

## **5.2: Energy sources in Nigeria**

Nigeria has been burden with the problem of inadequate electricity generation for a long time now; the PHCN generates electricity from 9 power stations (see table 6), which are six thermal and three hydro stations. The six thermal stations are Afam, Delta, Egbin and Ijora which run on gas, while Sapele power station runs on gas and steam, Oji River runs on coal and the rest like Kainji, Jebba and Shiroro runs on hydro and they are run on water (NEPA Press Release 2001

**Table 6: Electricity Production sources in Nigeria**

Site	Type	Installed capacity (MW)	Available capacity (MW)	No. of units
<b>Afam</b>	Thermal	700	488	18
<b>Delta</b>	Thermal	812	540	20
<b>Egbin</b>	Thermal	1320	1100	6
<b>Ijora</b>	Thermal	66.7	40	3
<b>Sapele</b>	Thermal	1020	790	10
<b>Jebba</b>	Hydro	570	450	6
<b>Kainji</b>	Hydro	760	560	12
<b>Shiroro</b>	Hydro	600	600	6
<b>Orji River*</b>	Thermal	60	-	4
<b>Others</b>	Diesel	46	18	-

\* Operational inactive

**Kainji Hydropower station** operates as two different hydropower plants; it gets its water from the major Nigerian river called River Niger. The power that generates from these two joint dams Kainji and Jebba dams are estimated as 760 MW and 750 MW respectively but the actual available capacities are 560 and 450 respectively too. This is the first Nigerian dam built in 1968 but the Jebba dam was commissioned in 1985, the smallest of all the dams in Nigeria. The Kainji reservoir serves throughout the year for both power stations, it is fill up during the wet season that is between August and December and drawn out during the dry season which is between January and August. In the privatization process, these dams are included by the FGN in other to restructure the power sector.

**Shiroro Hydropower station** is situated at the Shiroro Gorge on the Kaduna River close to Minna, capital of Niger State and close to Abuja, the Nigeria's federal capital, it was commissioned in 1990.

Its electric installed capacity is 600 MW and its available capacity is also 600 MW, it has a good technological standard since it generates 2,100 GWh of electricity annually, it drawn up its water for its reservoir during the September flood. As Nigeria's newest hydroelectric plant, it hosts Nigerian SCADA operated national control centre. Shiroro Hydro is also one of the power sectors towards privatization by the FGN (Onagoruwa 2010).

The total production of electricity in Nigeria is 4,000 MW and it is very below the country's consumer and business needs, despite the investment amounting to USD 1 billion annually (Corporate Nigeria 2010-2011). The Federal government of Nigeria has aimed to increase the generating capacity up to 10,000 MW by the end of this year, 2011. With this in view they plan to privatize its 11 regional electricity distribution companies 6 generating companies and to hand over the distribution to state governments as well as involving the private sectors too. The call for the electricity reform in the country is because of the inadequate supply and consistent power outages, which in 2010 the Nigerian president has followed the roadmap on, power reform by setting up different agencies to propel the on going privatization. These agencies are as follows:

- Nigerian Electricity Regulatory Commission (NERC) will supervise the industry and they are in charge of licensing market participants, setting market rules and designing tariffs and pricing. NERC has successfully licensed 19 independent power companies to generate power through the nine generating plants, eleven distributions and one transmission company, they have introduce the Multi-Year Tariff Order (MYTO) so as to encourage investors and private power producer; which provides for continuous reduction in transmission and distribution losses but it is under review.
- Presidential Task Force on Power (PTFP) which are involve in the improvement and predictability in electricity available, promote sustainable growth, restore consumers' confidence with a protection system, establish a competitive power procurement framework and also to establish and sustain effective communication with power stakeholders and the public.
- Bureau of Public Enterprises (BPE) is involve in the implementation of the policy on privatization, making recommendations on the appointment of consultants, advisers,



solicitors and other professional required for the purpose of either privatization or commercialization, also to ensure the success of the privatization through effective post transactional performance monitoring and evaluation.

- The Nigerian Bulk Electricity Trading Public liability company (NBET) has been incorporated in July 2010; they are responsible for the purchasing of electricity generated by power producers on behalf of the distribution companies until they become mature and attain credit worthiness.
- CPCS Transcom which is a Canadian-based professional services firm, they provide advisory services across a broad spectrum of infrastructure sectors which includes ports, rail, power, etc. They are in charge in the privatization of the generation and distribution of power sector in Nigeria, since they bring international expertise in the area of transaction structuring, public-private partnership, financial and economic modelling, legal and regulatory reform, operations, engineering and social and environmental advisory (PHCN, 2010-2011).
- This has shown government readiness towards building an enabling environment for investment in the power sector from foreign and private investors all over the world and within Nigeria too, and the following Electricity Distribution Districts has been scheduled according to BPE in addition to the generating power supply for privatization:
  - **Abuja Distribution:** Minna, Suleja, Lokoja and Lafia Districts.
  - **Benin Distribution:** Ado-Ekiti, Afenmesan, Akure, Asaba, Akpapava, Ugbowo, Ikpoba-Hill, Ondo, Sapele, Ughelli and Warri.
  - **Eko Distribution:** Fastac, Ijora, Lagos Island, Ajah and Agbara/Badagry with Benin Republic as a potential export market.
  - **Enugu Distribution:** Abia, Anambra, Ebonyi, Enugu and Imo.
  - **Ibadan Distribution:** Oyo, Ogun, Osun and Kwara
  - **Ikeja Distribution:** Ikeja, Shomolu, Alimosho, Ojodu, Ikorodu, Oshodi and Abule-Egba
  - **Jos Distribution:** Bauchi, Benue, Gombe and Plateau.
  - **Kaduna Distribution:** Makera, Doka, Birnin-Kebbi, Gusau, Sokoto and Zaria

- **Kano Distribution:** Kano, Katsina and Jigawa
- **Port Harcourt Distribution:** Bayelsa, Cross River, Rivers, Akwa-Ibom and parts of Delta States.
- **Yola Distributions:** Adamawa, Brono, Tabara and Yobe (Onagoruwa 2010).

While the Federal Government of Nigeria will continue to own the National grid but they plan to privatize the management within, then the non-core assets and liabilities as well as employees, right and obligation of the moribund monopoly will be managed by the Nigeria Electricity Liability Management Company Limited (NELMCO), this report has been the on-going progress on the privatization (Agbogun, 2007).

### **5.3: Challenges in Nigeria**

The power sector in a developing economy such as Nigeria has a lot of challenges for the government that initiated the project and the populace that are the consumer of the energy services, the challenges are discussed below:

- Political
- Economic and social
- Environmental
- Technical and planning
- Mismanagement/corruption
- Private generator sellers

#### **Political**

The political situation in Nigeria is not stable for investors since lot disagreements among different political organizations. There is a need to create and ensure a good level playing field for all stakeholders in the new power sector reform if the proposed objective of the government would be achieved. The activities going on in the Niger Delta is a great concern for all investors within and outside the country; since Niger Delta is the main source for Thermal and Hydro energy but the armed ethnic militia and youth's agitation will be a major problem for the incoming investors

in the power sector. The government would ensure the protection of the investment when it becomes operational.

### **Economic and social**

The plan of the Nigerian government is to provide effective and efficient power supply to its citizens that would be affordable too; this includes generating more power to the national grid and renovating the existing power stations that has been dilapidated. For efficient power supply, there would be construction of new power stations, by either the government or the Independent Power Providers (IPPs) and the cost of the investment is always expensive. The government would find a way to encourage the IPPs, since they are business oriented and they are there to make profit.

### **Environmental**

For Thermal or Hydro to be built in a given location, there is need to consider the nature of the environment; if for instance if a city has a cement industry, it would not be advisable to build a Thermal station there since the carbon dioxide emission around that area would be on the increase. So the government should be able to create an agency that would monitor and regulate the extent of pollution emission in a given area, which will affect its inhabitants. The environment is of great concern in the World view today, carbon emission should be reduce at every level, so Nigeria power sector investment should be focusing on environmental policy since there is any no such policy in Nigeria.

### **Technical**

The technology is not in Nigeria and it is a great problem for the country since they do not encourage young Nigerians that have the know-how, the need to increase the transmission line is of great concern. It is not just to produce more energy but how will it be transferred to the customers is an important point to consider, in Nigeria planning of projects are so weak and ineffective. The issue of power sector has been on ground over twelve years now, and no major step has been taken to improve it, despite a lot of money has gone into the project without any good outcome from it.

### **Mismanagement/corruption**

This is a major problem of the Nigerian government and its citizens. They cannot manage any resources properly. For over 50 years now the oil income or the resource rent has not been managed very well and this has affected the educational system, The Nigerian police, health and

all sectors of the society, bribing and corruption has been the order of the day; which has lead to unemployment and high rate of crime in the society and also vandalism of government properties.

### **Private Generator Sellers**

This is not a major issue but it has taken over all the activities of PHCN in Nigeria. All most every home, office, churches, mosques and even governmental agencies run electricity base on generator sets. Since two-thirds of the Nigerian population depend on private generator sets and the suppliers are not middle-class citizens but the elite in Nigerian society; companies like John Holt Plc, Fullmark, South-Atlantic Co. Ltd and so on, that have office-branches all over the 36 states of the federation, to stop the inflow of generator sets in Nigeria is a big problem because the sellers would sabotage the investment on power generation.

These are among the challenges that new investment companies would face in Nigeria; in the next few pages, I would discuss the prospect of small hydropower in Nigeria.

### **5.4: Summary**

In this topic, I have discuss the power sector situation in Nigeria, the way the government has planned to uphold the standard of electricity in Nigeria since the sector has suffered dilapidation. They planned it by establishing different organisations to handle the reform situation of the power sector, such organisations are the Nigeria Electricity Regulatory Commission, Presidential Task Force on Power, Bureau of Public Enterprise, The Nigeria Bulk Electricity Trading Plc and as well as the CPCS Transcom (management of the transmission grid). I also throw some light on the areas where the power distribution in different areas of the country. I also explain some problems/ challenges affecting the electricity sector in Nigeria; political, economic and social, environmental, technical, mismanagement and as well as private generator sellers, which are seen every day in the Nigerian society.

## **Chapter 6: Prospect of small hydropower**

### **6.1: Introduction**

Energy has been seen as an important issue for development in any given country, it is also an engine of social and economic opportunity in that no country can manage to develop beyond a subsistence economy without having at least minimum access to energy services for the larger proportion of its population (Steer et al., 2000). The private sector introduction in Nigeria started with the democracy government from 1999, which paved way to approve certain policy agenda that would encourage energy supply companies because of the fast growing population in Nigeria. Nigeria is has a lot of natural energy carrier resources which includes oil, natural gas, coal, and lignite, tar sand, hydropower (large and small), solar radiation, wind, biomass (wood, animal and plants wastes), nuclear element deposits, these resources have not been tapped in-depth and since the population is on the increase, the energy demand is always above production which means that energy supply is a major issue and the most priority of the county.

Hydropower has been in function before the discovery of crude oil in Nigeria, as a developing country with low level of literacy, the resource rent from vast deposit of crude oil lead to the abandonment towards the development of hydropower which resulted that the 3 major hydropower (Kainji, Jebba and Shiroro) were performing under below installed capacity. During the introduction of the road map in energy sector in 2005, a lot of Independent Power Company was set in places, which are mainly on thermal energy but with the energy situation in Nigeria whereby gas which is needed for these thermal stations are been flared because of lack of infrastructure, oil production has been affected by bunkering, sabotage and the Niger Delta insecurity and the attacks on the oil fields been shut down, and the Niger Delta situation where the fossil and gas energy has been located has shown the conventional energy sources had failed the nation.

Water has been a great source of energy that has different purposes; water in form of hydro energy is seen as the leading form of electricity generation but with the introduction of small hydropower stations. In China, a total of 42,000 small hydro stations has been build with an installed capacity of over 35,000 MW, which has lead to the fast development in China (Kucukali and Baris, 2009). Nigeria has also a lot of small hydropower (SHP) potentials, if you take for instance the amount

of rivers and dams available in different states which could be a major development towards those remote off-grid communities and as well as grid based power generation.

## 6.2: Small Hydro Energy in Nigeria

**Table 7: Hydropower Potentials in Africa**

Country	Hydropower Potential (MW)	Current Installed Capacity (MW)	Percentage	Electricity Access Rate
Angola	18 000	527	3%	15%
Cameroon	20 000	720	4%	47%
Congo DR	100 000	2446	2%	6%
Ethiopia	30 000	796	3%	15%
Gabon	6 000	170	3%	47%
Madagascar	7 800	150	2%	15%
Mozambique	13 000	2199	17%	6%
Nigeria	20 000	1301	7%	40%
South Africa	10 000	*2000	20%	> 70%
Zambia	6 000	1760	29%	19%

Nigeria ranked high in hydropower potential in Africa with 20,000 MW expect from Congo DR and Ethiopia. The current installed is 1301 MW with a 7% percentage of her potential each year. But Nigeria has a gross exploitable large hydro potential of 14,750 MW out of which 14% amounting to 1930 MW is harnessed, contributing approximately 30% of total installed grid connected electricity generation according to Prof Abubakar Sani Sambo, of Energy commission of Nigera-(ECN). ECN also started that SHP has been presence in Nigeria since 1923, which is 45 years before the commission of Kaniji dam; the first large hydropower in the country but it seems that the dam is still in its development stage of its life spam due to neglects and mismanagement of the oil rent in the country. In 2004, according to REMP, there is an estimate of 277 sites with a capacity of 3500 MW, which represents 23% of the nation's hydropower potential in addition to the 734 MW that had been surveyed in 1980 in some states. The SHP is still not exploited in Nigeria but in other to reach the goal of 2020, it should be looked into for development. The next diagram shows the river basin possibilities in Nigeria that can be exploit and develop towards the economic development of each state.



**Figure 10: River basin map of Nigeria by Awachie**

During the year 1976, the river basin of Nigeria was divided into 11 according to the River Basin Development Authorities (RBDAs):

1. Sokoto-Rima Basin,
2. Hadejia-Jema'are Basin
3. Lake Chad Basin
4. Upper Benue Basin
5. Lower Benue Basin
6. Cross-River Basin
7. Anambra-Imo Basin
8. Niger Basin
9. Niger-Delta Basin
10. Benin- Owema Basin
11. Ogun- Oshun Basin

These Basins was mapped out for the following purposes: hydroelectric power generation, irrigation, navigation, fisheries, and recreational centres and as well as irrigation and water supply.

The second idea behind the mapping out of the river basin is to see how small, medium and large dams can be constructed to hold surface waters since Nigeria has a good topography that are from lowlands along the coast and lower Niger valley to high plateaus and mountains in the northern part of the country with an elevation from 600 m to 2042 m which could be seen also along the eastern region, most of the dams as well as the rivers have a good elevation for the construction of SHP in all the river basin.

### **6.3: Government policy towards small hydropower plants**

The federal government of Nigeria has witness the failure of the thermal plants because of the inadequate supply of gas to the station and the ethnical dispute over the area of the Niger Delta. Electricity generation from renewable energy source has been encourage in the developed countries and the main fiscal instruments they used to promote the investment are fed-in-tariffs, quota obligation, tender and energy tax exemptions (Kucukali and Baris, 2009). However to achieve the road map towards electricity, there is need for the government to look into the existing energy sources and introduce full exploitation and promotion, which can come in form of SHP, since there are a lot of potentials and it would be regarded as a potential most stable and economically clean energy in Nigeria. The reform through the National Electric Power Policy (NERC) has encouraged the private sector to apply for and obtain a license to build and operate a power plant as far as it generates more than 1 MW. With the establishment of the Rural Electrification Agency (REA) and Rural Electrification Fund (REF), whose main objective is to encourage investments towards the renewable energy resources in Nigeria. According to NERC, an individual can construct, own or operate an off-grid power plant, but it would not exceed 1 MW, which is seen in the Electric Power Sector Reform Act (EPSR) of 2005 and this exemption from holding a license encourages investment in the mini and micro SHP generation in those area of off-grid which are seen in the rural areas.

NERC has in recent times issued a total of 29 licenses, which includes 20 for grid connection, two each for embedded and distribution and five others for off grid generation. Those in operation are five in number while four others are ready for commissioning, six out of the eight grids generators are in operation while the remaining two will start up as soon as possible. But with this entire framework towards upholding the electricity sector and private sector investment, it all seems that all the investment was channelled to fossil-based sources (oil and gas) and not in the hydropower and other renewable sources that are visible in Nigeria, I guess it is because of the non existence of



a quality hydrological database in the country. So private investors in the renewable sources would be based on importation and marketing, since NEPP and NEP has encouraged investment towards the maximum utilization of SHP potentials, they foresee the feasibility of the hydropower potentials to exceed 29,800 GWh/year and this was calculated before the enactment of NEPP.

#### **6.4: SHP – a sustainable energy technology**

According to Dudhani et al. (2009), SHP projects are generally considered to be more environmentally favourable than both large hydro and fossil fuel powered plants because they do not involve serious deforestation, rehabilitation and submergence. In energy development, it is best considered to be sustainable within the society, which project should be a long term, readily available and at a reasonable cost which would not eventually cause any societal impacts. In Nigeria, the emission factor from gas is calculated to be 670 g carbon dioxide/kWh but if a hydropower plant operates for 7000 h/year, the results show that it has saved 11,500 tons carbon dioxide emissions/year while an anticipated lifetime of 25 years will surely result in carbon dioxide savings up to 290,000 tons emissions if hydropower plants are been used. The small-scale hydropower is competitive economically if compared with small-scale fossil fuel or steam electricity plant, if they are located to a city or where consumption is high. Therefore, it is better to think about renewable source of energy in Nigeria as far as development is concerned.

#### **6.5: Financing SHP in Nigeria**

The cost of financing any renewable energy project is very high and has a long-term financing period, since the technology is not within the country and where a country economy has unfavourable macro-economic conditions. So a special fund called the Renewable Electricity Trust Fund (RETF) was enacted by the Federal Government of Nigeria to encourage the expansion of renewable electricity in the country, which would be managed by the Rural Electrical Fund (REF); they shall promote, support and provide renewable electricity through private and public sector participation. According to International Energy Agency (IEA), Nigeria would benefit a lot of grants from investment in the renewable projects since investment towards sustainable electricity has been put in place by the Nigerian government. The Federal government has also announced that by April 2011, the tariff for electricity would be increased in order to encourage investors' return on investment. The Federal government has stated this through the

NERC, maintaining that it was ready to work with the National Mathematical Centre in the development of mathematical models for tariff setting in the Nigerian Electricity Supply Industry (NESI). The Commission's Vice Chairman, Mohammed Lawal Bello, in his comment said that collaboration between the two government agencies would be mutually beneficial and relevance to the power sector. (Daily Independent, 2011)

## **6.6: Price, risks and hedging in electricity**

### *6.6.1: Price*

Electricity privatization or liberalization has lead to electricity market competition in nearly all IEA countries during the 1990s, from the generation down to the retail form, which, has improved the economic efficiency of the power sector. The price is seen as the main factor to consider in an investment since every investor would expect a good return on investment. In Europe, there has been political crisis related to electricity prices, large numbers of customers are used to a steady price over many years but when exposed to these high prices, they always turn out to put the blame on the government to normalize the price. In the past, there have been several electricity markets that have experience high spot prices; Nord Pool countries and New Zealand for instance, see table 8.

**Table 8: Electricity prices crisis**

Country	Causes of price crisis	Duration	Government response	Outcomes
<b>Nord Pool (Norway)</b>	Tight energy supply due to low rainfall/cold winter	12/2002-3/2003	Let market respond	Large imports, significant demand response
<b>New Zealand</b>	Tight energy supply due to low rainfall and concerns about available thermal fuels	4/2003-6/2003	Demand reduction, commission to acquire generating capacity for dry years	Crisis averted through savings and increased rainfall.

*(Energy Market Reform. 2003)*

The level of risk to be taken should be measure with the level of return on investment, since investment in the power sector is cost intensive and there should be an increase in the price electricity to the consumers.

#### *6.6.2: Risk in Electricity Market*

The level of risk estimated by an investor in a power plant will be redirected in the level of return projected on that investment, the risk associated to electricity power sector is so vast; the spark spread, investment options, control on future carbon dioxide. The spark spread is the different between the market price of electricity and its cost of production, these measures is very necessary because it helps the investor to understand its bottom line profit in the electricity production. For any fossil-fired power generation in an open market, there are always risks associated with the price of crude oil and the price of electricity; the cost of natural gas is on the increase too and investments are always sensitive with fuel prises and price volatility. The second risk is the investment option; electricity power sector investment could come in different forms; fuel or gas

powered, renewable energy, coal and nuclear energy. The different technology introduced has a different risk that comes with it; in the table below, there is a risk profile that shows the risk characteristics of different form of technology and investment in the power sector.

**Table 9: Qualitative comparison of Generating Technology by Risk Characteristics**

<b>Techno-logy</b>	<b>Unit size</b>	<b>Lead time</b>	<b>Capital cost/kW</b>	<b>Opera-ting cost</b>	<b>Fuel cost</b>	<b>Carbon dioxide emissions</b>	<b>Regulatory risk</b>
<b>CCGT</b>	Medium	Short	Low	Low	High	Medium	Low
<b>Coal</b>	Large	Long	High	Medium	Medium	High	High
<b>Nuclear</b>	Very large	Long	High	Medium	Low	Nil	High
<b>Hydro</b>	Very large	Long	Very high	Very low	Nil	Nil	High
<b>Wind</b>	Small	Short	High	Very low	Nil	Nil	Medium
<b>Recip. Engine</b>	Small	Very short	Low	Low	High	Medium	Medium
<b>Fuel Cells</b>	Small	Very short	Very high	Medium	High	Medium	Low
<b>Photovoltaic</b>	Very small	Very short	Very high	Very low	Nil	Nil	Low

*(Energy Market Reform, 2003)*

Gas-fired technology has good characteristics under these conditions, it has a relatively low cost of capital, short-term lead, and so on, the flexibility in operation also provides a good advantage for investors. But the natural gas price is the main risk factor that has an effect on this kind of investment. Nuclear power plants, has also a relatively low proportion of fuel and cost of

operation but a high cost of investment which reflects the risk associated to it. The coal power plants, has a very capital intensive and its environmental consequences is on the high side too, which is the risk associated to it.

Hydropower plants, can be seen in different forms, the large ones has a very large cost of capital, and the lead time during construction period is also long, and it is subject to delays and the cost of borrowing to finance the project would be on the increase too, But the small hydropower plants are so economic friendly with the nil emission of carbon dioxide, while it seems that small hydropower has not been initiated in the developing countries instead they are into the large hydropower which has a lot of lead time and more expensive too. The other renewable like solar (photovoltaic) and wind has a high cost of capital, low operating cost and short lead-time. But the risks associated with this later type of renewable is the amount of the wind blowing and the rate of the sunlight during the day, in developing countries, this could not be the issue because there is an ample amount of wind and solar resources.

The use of reciprocating engines and the fuel cells are determine by the availability of fossil fuels, it has a short lead time, it can also be installed when the electricity prices are high, and it could be located at the consumer site. The form of power generation is very well seen in the developing countries, whereby individuals have a generator engines for power generation whenever the power is not stable and cost of electricity is high but the risk associated to this form of power generation is the ever increasing cost of fossil fuels, on the other hand, it could be a form of hedging for high prices on electricity. This will take us to the next topic, which is hedging.

### *6.6.3: Hedging*

Hedging is simply the investment one does to limit or reduce losses. The risk associated in investing in power plants are so high relative to the prices the consumers are willing to pay for the service, so a lot of investors have shift the risks to hedging the risks, it could be through financial hedge, contracts hedge and organisational hedge. The financial hedge involves the use of futures and forward markets tools in the development of electricity market efficiently. The Nord Pool is the best example when we talk about hedging, where the futures and forwards market exist in the Nordic countries. The electricity in the Nordic countries has taken a long time to develop, which the introduction of Elspot, Eltermin and Eloption. But the insufficiency of the financial market has left the electricity power companies to hedge on short-term risks, investors could foresee their price curve and invest their income stream afterwards, the financial hedge has seen to have a shorter time than the investment life span. This is not favourable for any electricity company

investor. The contract hedge is an option that exists between the generators and consumers, which, allows the generator to contract a long-term contract with the consumers, large consumer company are always interested in this form of hedging since there could be price stabilization with the generation company. But the privatization process do not accept this form of contract since it always bring a disagreement associated to long-term contract prices not more than three years (Littlechild, 2002). But the existence of consumer co-operatives exists with the generation company and the contracts with an electricity retailer that has a very large stable based consumer. While in organizational hedging, electricity power investors would be able to hedge over availability resources, volatile prices and so on. To achieve this, investors in the gas-fired generation purchase companies with upstream natural gas assets in order to hedge high cost of fuel prices. There is also a possibility for gas-electricity investors to merge with a gas production company in other to avoid the same risk above since price is so volatile in nature. Mergers is one of the mechanism to improve the prospect of stable cash flows as a source of finance for larger, capital-intensive (Thomas, 2003).

## **6.7: Summary**

In this chapter, I started with the prospect of hydropower in Nigeria, I showed the locations that have been mapped out by the River Basin Development Authorities (RBDAs), and they are potentials for small hydropower development. These river basins are located in different part of the country and followed by government policies towards development of the power sector through NREC, whose main job is to issue license to different private investors toward electricity, a total of 29 license has been issued by this organisation but most of it has been in the Thermal energy which could not provide the power the country needs. This chapter also discuss the price mechanism and the risk involve in investment in the power sector, while I concluded with different form of hedging approach that investors faces while investing in the power sector.

## **Chapter 7: Data Analyses**

The introductory, methodology, theory, and empirical data has been studied, this chapter is focused on my data analyses from the primary and secondary sources, since I am doing an exploratory research, all the primary data was describe alongside with the secondary data so as to understand the research question and sub-questions that I asked. The way I did my analyses is described in chapter 3.4, documents from the NVE, SKS, Norad, Energy Policy and Nigerian Medias were so valuable and it added to the knowledge about the topic. The analysis of the document was done by taking out the interesting parts; which helped me to understand the problem statement. The interview I did took a long time to analyses but after transcribing the information in a bullet point form, it was easy to describe and organized, I also used the secondary data while categorizing and comparing the primary data.

I develop some research objectives that would help the reader to understand the question I asked in my problem statement:

*“How could Norwegian clean energy technology be implemented in Nigeria and what are the implications”?*

In order to answer the main research question, the following sub-questions below are formulated:

- How effective is the existing policy able to attract investors?
- What is the level of Infrastructure and renewable energy policy?

The two questions above was derived from the primary and secondary data I collected, and the results from the above questions helped me to implement the theory i have studied which are privatization theory and economic growth theory, which I used to analyse the process the Nigerian government put in place to encourage investors in the power sector since there would be job creation and is it towards renewable projects or not and what are the level of infrastructure available in Nigeria; all these questions showed how possible or impossible the clean energy technology in Norway can be involve in the Nigerian policy. Each of the objective questions serves as a heading in analysing my report.

### **7.1: How effective is the existing policy able to attract investors**

The purpose of this sub-question is to understand how the policies that The Federal government of Nigeria has initiated will welcome foreign investors. The primary data I collected from respondents was compared with the secondary data, while comparing it; there is a level of validity in the report. The incentive policies that have been set up to encourage investment in the power sector are as follows:

- A Tax Holiday of up to five years.
- Exemption from Duty Taxes on imported equipment.
- Capital and investment Allowances which can be carried forward and used after tax holiday period.
- Manufacture of transformers, meters, control panels, switchgear, cables and other electrical related equipment are considered as pioneer product or industry. As a result, there is tax holiday of 5 to 7 for investors who invest in these areas.
- Power plants using gas are assessed under the companies income tax act at a reduced rate of 30%.
- 100% foreign ownership of Electricity plants and a Repatriation of profit with a 5% withholding tax (NIPC, 2011).

Including the World Bank Groups (WBG), which offers several financing and guarantee products that shows the comfort in investing in the Nigerian power privatization program through The World Bank Partial Risk Guarantee Program.

I also consider the pros against the cons in doing business in Nigeria, the cons which I mentioned in my empirical data, in discussing the pros against the cons of investing in Nigeria using both reports from my interviewee and secondary data, I mentioned the cautions that every investor should consider before investing and the way the government has tackled it:

**1. Weak in currency (Naira)**, which in February 20, 2006, the Central Bank of Nigeria introduced the Whole Dutch Auction System (WDAS), to stem the depreciation of the Naira and liberalizing the Foreign Exchange Market, the WDAS has been achieving its objective to a certain extent. They have unified the exchange rate between the official and Inter-bank Markets and resolved the multiple currency problems. Also they have facilitated the greater market determination of exchange rates for Naira vis-à-vis other currencies.



**2. High cost of funds**, all investors has to raise fund at one point or the other, since the availability of fund often determine whether there is an opportunity to invest or not, the World Bank Group has listed certain contractual payment obligation in its Partial Risk Guarantee Scheme which is expected to benefit the power Generation and Distribution investors via the bulk traders, each investor must discuss directly with the WB Groups on the type of cover needed and if the WBG would be willing to provide it. Also the Central Bank of Nigeria (CBN) has a special fund to assist any company investing in the power sector. With this approach, the cost of funds that are available in Nigeria is not very high as indicated as a problem in investing in Nigeria.

**3. Advance Fee Fraud (419) and corruption**, this has been the situation in Nigeria whereby, a Nigerian fraudsters send uniform letters, faxes or email to several foreigners listed directories claiming to be in position to transfer huge sums out of the country and offering them individual huge sums of money in exchange for the use of their accounts, while corruption is the payment and receiving of bribes for preferential treatment. The Federal government has enacted different organizations to tackle these problem, such organizations are: Code of Conduct Bureau of 1999, which is established to ensure high standard of morality in the conduct of government business, whereas the other is The Economic and Financial Crime Commission (EFCC) Act of 2002 and Establishment Act of 2004, they are Financial Intelligence Unit in Nigeria with the responsibility of coordinating the various institutions involved in the fight against money laundering and investigation and enforcement of all laws dealing with economic and financial crimes in Nigeria, the third on is The Independent Corrupt Practices and Other Related Offences Commission (ICPC) Act of 2000, which was enacted to prohibit and prescribe punishment for corrupt practices and other related offences. The corruption practices in Nigeria has reduced in recent years, in 2008, Nigeria was ranked 154<sup>th</sup> of 160 corrupt countries but in 2011, the statistics showed the most corrupt countries in the world, while Nigeria has been excluded, showing that the country has really stepped up in cutting the corrupt practises that has been in the country for many years (Ali, 2010).

**4. Environmental**, this has been the main issue in Nigeria, there has not been any policy in relation to the environment, it seems that environmental concern is not an immediate priority on the agenda of the Nigeria's electricity power reform, the opportunity offered by the process for laying a solid foundation for sustainable development of the electricity power industry is not encouraging in Nigeria. Since there are already 6 thermal power stations, my interviewee said that "investment in the thermal energy is very cheap and the need for electricity power in the country is very high", the carbon dioxide issue is not considered in the white paper but there are plans to

develop small hydropower stations and other forms of clean energy. Meanwhile, the Nordic countries have signed a memorandum of understanding (MoU), as a result of the long and close cooperation between the Nigeria energy sector and the Nordic countries, the MoU was signed by the Honourable Minister of State for Power and Steel Nuhu Somo and the Nordic Embassies in Abuja (Sweden, Finland and Norway) on April 15<sup>th</sup>, 2011. The MoU focuses on cooperation, collaboration and sharing of information between Nigeria and the Nordic countries within the energy sector, aiming to secure and develop the various options for investment opportunities in the Nigerian power sector, while in 2010 there was a press conference in Abuja with the Federal Ministries of Power, Water Resources and Environment with the Nordic embassies in Nigeria to discuss the hydropower, renewable and thermal energy, bio-and waste-to-energy projects as well as on transmission and distribution lines (Wæringsaasen, 2011).

My primary and secondary data attest to this improvement towards the hydropower sector in Nigeria, another interviewee from one of the Nordic embassy said that “they are interested in the business part of it and not in the environmental since it is the government that has the right to reform their environmental policies and not the investors”. The environmental issue has not been considered as a major threat now but I foresee in the future whereby Nigeria would be included in the Kyoto protocol in their carbon dioxide management, unless investment in the renewable would be a form of Clean Development Mechanism (CDM) from the Annex 1 Countries.

**5 Political Uncertainty**, Nigeria has been experiencing longstanding ethnic and religious tension, although both the 2003 and 2007 presidential were marred by significant irregularities and violence, Nigeria is currently experiencing its longest period of civilian rule since independence. The general elections of April 2007 marked the first civilian-to-civilian transfer of power in the country's history, according to the NEWS from All African.com, the election on April 16<sup>th</sup> 2011 has been seen as a true and fair, it goes further to say that the US president Barack Obama commended the president Goodluck Ebele Jonathan and said that “the success in the conduct of free and fair polls, Democracy, however, neither begins nor ends with elections” but to move forward, Obama stressed that “now is the time for Nigeria's leader and its people to come together and build the future that they deserve-a multi-party democracy that addresses the aspirations of all Nigerians, especially its youth, who did so much to make the recent elections a success and who will define the nation's future”. The success of the election has opened a new chapter in the country's political situation and the country towards economic development, since the US president Obama emphasized that “Today, Nigerians have an historical opportunity to move forward together and make their nation into a model for Africa”. He also reviewed his previous

statement that “he is looking forward to strengthen partnership with Nigeria so that the future generations of Nigerians can live in peace, democracy and prosperity”. Comparing my primary and secondary data, I can add that the political security in Nigeria has reduced to an extent, but there are still some anti-democratic citizens living in Nigeria whose activities is to cause violence in the country.

**6 Private Generator Sellers**, like I mentioned in my empirical data that this is not a major issue but they are the main industry that substitute the PHCN activities in Nigeria, from my category 1B point of view, he maintained that the private generator sellers can not in any way interrupt the road map for privatization, he said that “when the development of Information technology (IT) were been introduced in Nigeria, most people think that the computer data machines cannot replace the old type-writer machines but currently no old type-writer machines are been used in any office again” so this would be the facts of all the generator sellers in Nigeria, when there would be a steady power supply, no Nigerian invest in it. Moreover, he added “there are equal opportunities for the private generator investors to rethink and invest in the new power reform sector since the government has opted for Public Private Privatization (PPP)”. And that the Multi-Year Tariff Order (MYTO) methodology would be of advantage for them since MYTO provides for continues reduction in transmission and distribution/retail loses and different tariff methodology for regulating electricity prices while the tariff is cost reflective. Which is one of the main functions of the Nigeria Electricity Regulatory Commission (NERC)? Category 1A said that “the existence of the private generator sellers would not affect the investments, besides it will complement the project, the investment will take a reasonable amount of years, there is need to have them as a second source or back up”.

So with all this policies in place, there are additional reasons why companies should invest in Nigeria and they are as follows:

- Abundant resources, which are yet to be fully exploited. These resources include gas, solar, hydro, bio-energy, unclear, and wind energy as well as agriculture.
- Large market, Nigeria offers the market in sub-Saharan Africa, with a population of about 150 million people; the Nigerian market also stretches into the West African sub-region.
- Free market economy, the Government has created a favourable climate for business and industrial ventures. Administrative and bureaucratic procedures have been greatly

streamlined. The Government has put in place policies and programmes that guarantee a free market economy.

- Robust private sector, which is visible in the country through the private sector, which has assured greater responsibilities under the new economic environment.
- Free flow of Investment, the exchange control regulations has been liberalized to ensure free flow of international finance. There is now unrestricted movement of investment capital.
- Skilled and low cost labour, there is an abundance of skilled labour at an economic cost, resulting in production costs, which are among the lowest in Africa.
- Infrastructure, there has been a rapid development of physical and industrial infrastructure, in terms of transportation, communications, electricity and water supply.

The Federal Government of Nigeria has put in place in order to encourage investors in the power sector, according to my interviewee in category 1B “there are a lot of great hope for Economic Development in the electricity reform programme, since more than 330 investors has submitted application to the Bureau of Public Enterprises (BPE) expressing their interest in the privatization programme already and if we take a look at Telecommunication sector, that brought about a lot of economic growth and development in the telecom sector after it was privatized, MTN Nigeria, been one of the first telecom companies that secured one of the four licenses to operate digital GSM (Global System for Mobile Telecommunications) telephone on February 9<sup>th</sup> 2001, from the Nigerian Communication Commission (NCC)”, he added that “there has been economic development in the telecom sector and a better service has been since in the telecom industry with a lot of competitions with other private telecoms like Globalcom, Zain, Mtel and many other medium private telecom companies. Not to mention before now the Nigeria Telecommunication Limited (NITEL) was dilapidated and was unreliable just like PHCN is today. He strongly believes that privatization would go a long way in the economic growth and development of Nigeria.”

Another interviewee category 3B they said “that for the federal government to achieve their proposed plan, there is a saying that says (you have to break eggs to make an omelette)” while another said that “privatization without competition is a fraud” in other words, there would be economic growth and development but a lot of people would be affected in the process, the current

workers in PHCN, the petrol and gas stations and generator sellers too. But the next page will describe the state of the infrastructure in Nigeria.

## **7.2: What is the level of Infrastructure and renewable energy policy?**

The transmission and distribution networks are poorly maintained and inefficiently operated which makes it difficult to move power from generation sites to consumption point. The level of infrastructure in Nigeria has depilated, the main challenges facing the electricity sector are overloaded transmission lines and sub-station, inadequate coverage of infrastructure, limited funds for development projects, limited training opportunities and community issues during project execution. The need for a new infrastructure is needed in the power sector, It is not just enough to generate power adequately without recourse to the strength of the existing transmission line capabilities as well as how the power could be used for the overall interest of the country, there has been an ongoing plan on the transmission line, which involves the following:

- All power stations to have alternative evacuation routes.
- All states capitals to generate 330/132 kW.
- All local government headquarters to generate 132/33 kW.
- All major towns, local governments and state capitals to be on dual source of supply.
- All transmission stations to have at least 2 transformers that are less than 75 per cent loaded at any time.
- All transmission stations to be rehabilitated for automation operation.
- There should an interconnection with neighbouring countries power exchange.

To be able to achieve this extension plan, the Federal Government of Nigeria has planned to improve the distribution grid lines also in the next 5 years and they plan to have:

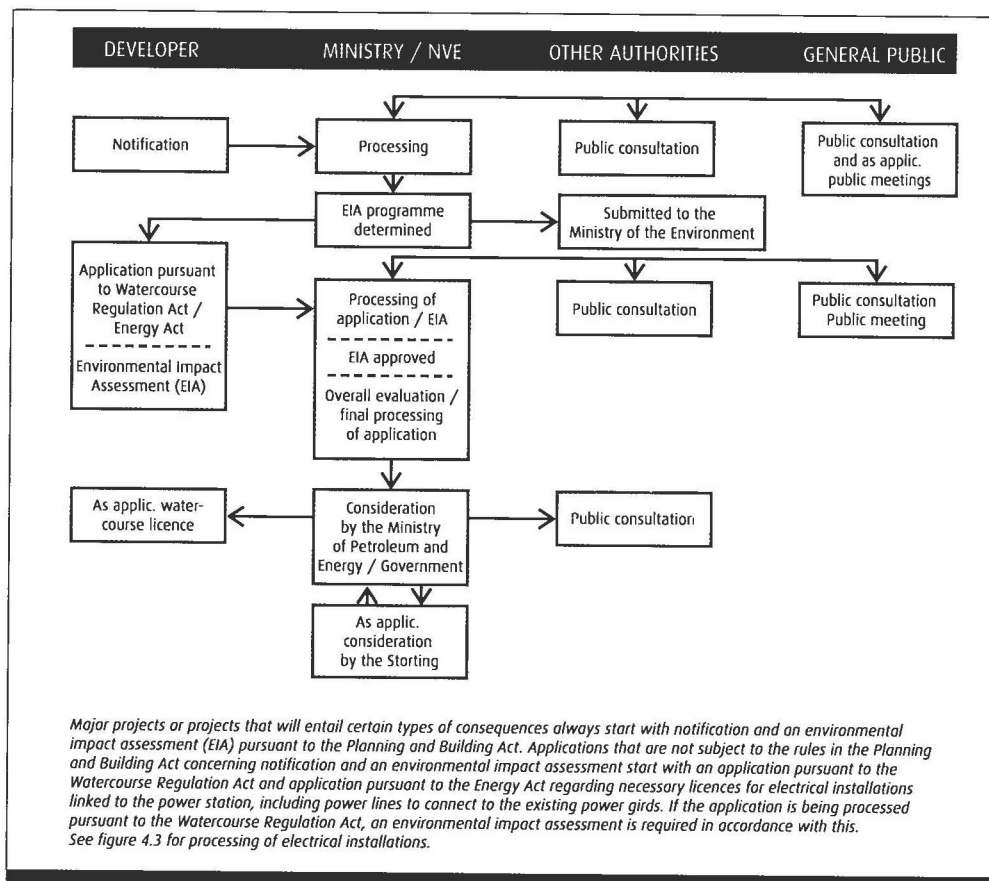
- 2,460 km of 760 kW line with 3000 MW capacities.
- 2,349 km of 330 kW line with 3,900 MW capacities.

- 2,353 km of 132 kW line with 3680 MW capacities.

With this plan on ground, there would be an improve system wide voltage profile, especially in the northern parts of the network, a positive impact on system security since there is a sufficient transmission resources in place, there would be electricity loss reduction and as well as an increase access to electricity.

According to my interviewee in category 1B, he said, “new investors are encouraged to build, own and operate the various thermal plants, and as for hydro plants, there is a concession with the government of Nigeria over 25 years with the Nordic countries.”

Nigeria has renewable energy resources like solar, wind, bio-energy and hydro, but the challenging thing is that, there is need to approve and implemented the National Energy Master Plan (NEMP). According to my secondary data, the NEMP incentive covers the whole aspect of the energy sector privatization in the country. The energy policy in Nigeria welcomes the Clean Development Mechanism (CDM), International Institutions like World Bank and United Nation Development Programme (UNDP) and other NGO. While in Norway, my interviewee in category 1A said, “the Protection Plan and the Master Plan for licensing according to NVE was establish because of the conflicts between environmental interest, hydro developers and the authorities”. Below is a diagram showing the process of licensing (figure 11).



**Figure 11: Licensing process in Norway (Bogstrand, 2008)**

The result in the above diagram shows that in Norway environmental issues are part of the main discussion for any developer or investor, there would be a public hearing with the government before any project would be establish. While, in Nigeria environmental concern is not an immediate priority on the agenda of the electricity power reform. The amount of fossil resources deposit in the country is said to be in abundant and the country is currently depending on the resource rent. For development, my interviewee in category 2A, said that “the commercialization of the power sector has brought about a lot of mergers of different companies and in different counties also, that it has increased the service and availability of electricity in Norway, he also commented on free investment has been a problem in Norway”. While category 2B said that “they are in Nigeria for the business aspect of the investment, so there would be economic improvement but it also depends on the literacy capacity available in the country.

While category 3A believes that “the price of electricity is on the high side now, since they have to pay not just for the power used but also for the cable price too that electricity should be in the hands of the government instead since it is for the masses benefit.”

### **7.3: Summary**

From the above analyses, I can summarise that the privatization process in the Nigerian electricity sector is the best approach to handle the effectiveness and the efficiency of the industry, the policy that has been put in place with all the incentives would encourage foreign investors since there is hope for return on investment.

The neglect of an environmental policy is a big setback for the country, because for any renewable project to be implemented, the environment would be affected and the communities would be also affected too. The rural communities in Nigeria where most renewable projects would be located are not educated, they can be lured into violence activities to the proposed investors just like the case of the Niger Delta and the Northern youth violence that cause the kidnapping of oil expatriates and destruction of properties respectively.



## **Chapter 8: Conclusion and further research studies**

In this section the final conclusion for the problem statement of the research is been provided. Among other things with the problem statement, which is how Norwegian clean energy technology could be implemented in Nigeria and what the implications are, I included further research work that would be needed for the development of the power sector.

### **8.1: Findings**

The road map for privatization in the electricity sector in Nigeria has been viewed as the best approach to handle the dilapidation of the electricity power sector, during the analysing of this research work, I found a major setback that need to be reconsider, which are:

- The issue of environmental policy, my interviewee commented that the privatization of the telecom lead to economic growth in telecommunication in Nigeria but the infrastructures locations are not located with the International standards, most infrastructures are located behind family residential buildings. There is no environmental policy guiding investors and the communities.
- The policy lack communication with the public in their decision-making, knowing full well that the public will bear the cost of the investment through an ever increasing in the electricity prices.
- There are some blockages in the system; different governmental organisations involved have not the knowledge or directives needed to ensure an efficient processing of application.
- Human resources are lacking, since majority of the power sector workers would be displaced from office due to lack of technical know-how.

In order to reach the goal of 2020 that was set, the government needs to provide the investors more formalised assurances, there is also need to have an international policy incorporated in the decision-making; Nigerians needs electricity but we should have clean energy investors in place since the world is clamouring on clean energy. The corruption in the system is still on the high side, most government officials do not think about service to the people, which will result in

mismanagement of the fund allocated to different investors. I believe we can reach the target in 2030 if the ambitions are followed up with practical government actions

## **8.2: Further research studies**

Nigeria is the giant of Africa; this further research work would contribute to the existing plans and policies that are exists in Nigeria. Some further research studies have been identified and they are stated below:

Firstly, the need to develop the Nigerian Bulk Electricity Trading Plc (NBET) is an area for further studies since the government plans to connect with her neighbouring country for sufficient electricity supply, which will involve spot markets, future contracts and as well as hedging.

Secondly, the regulation for pricing the electricity output is a complex system, which involves advance technical know-how to be put in place; a good research investigation would be recommended for further studies and it would be beneficial for the government.

## References

- Aderinokun, K. 18 January 2011. PHCN Transferred to NELMCO, Thisday newspaper. Downloaded 11 April 2011 from <http://www.thisdaylive.com/articles/phcn-tranferred-to-nelmco/84995/>
- Ali, M. 13 January 2010. Most corrupt countries or Nation ranking 2010-2011 of the world, highest corrupt governments. Downloaded 1 April 2011 from <http://www.einfopedia.com/most-corrupt-countries-or-nations-rankings-2010-of-the-world-highest-corrupt-governments.php>
- Amanze-Nwachuku, C. (12 April 2011). Indian Firm to partner with buyers of PHCN Coys. Downloaded on 12 April 2011 from <http://allafrica.com/stories/201104120473.html>
- Awachie J.B.E (No Date) Perspectives, Prospects, Planning and Problems in Basin Management and Development. downloaded on 15<sup>th</sup> April 2011 from <http://www.fao.org/docrep/008/ad793b/AD793B01.htm>
- Anonymous (1999). *Building transparency into the privatization process*. London, UK: Adam Smith Institute
- Anonymous (2006). *Renewable Electricity Action Program*. Abuja, Nigeria: Federal Ministry of Power and Steel. Downloaded on 6 May 2011 from <http://www.fmps.gov.ng/>
- Anonymous, U.S. Department of Energy (without date). Types of hydropower plants. Downloaded 10 April 2011 from [http://www1.eere.energy.gov/windandhydro/hydro\\_plant\\_types.html#sizes](http://www1.eere.energy.gov/windandhydro/hydro_plant_types.html#sizes)
- Anonymous (2008). *Hydropower resource assessment of Africa*. Paper presented at the Water for Agriculture and Energy in Africa, Ministerial conference on water for agriculture and energy in Africa: the challenges of climate change, Sirte, Libya, 15-17 December 2008. Downloaded 11 April 2011 from [http://www.sirtewaterandenergy.org/docs/2009/Sirte\\_2008\\_BAK\\_3.pdf](http://www.sirtewaterandenergy.org/docs/2009/Sirte_2008_BAK_3.pdf)
- Anonymous (2006). *The Nigerian statistic fact sheets on economic and social development*. Abuja, Nigeria: National Bureau of Statistics
- Anonymous. 29 October 2010. Sustainable solutions for the power sector. Royal Norwegian embassy in Abuja, Nigeria. Downloaded 11 April 2011 from [http://www.emb-norway.com.ng/News\\_and\\_events/oil/Sustainable-Solutions-for-the-Power-Sector/](http://www.emb-norway.com.ng/News_and_events/oil/Sustainable-Solutions-for-the-Power-Sector/)

Anonymous (2011). Why Invest in Nigeria. Abuja, Nigeria: NIPC. Nigerian Investment Promotion Commission (NIPC) One Stop Investment Center. Downloaded on the 2<sup>nd</sup> of May 2011 <http://www.nipc.gov.ng/whyng.html>

Anonymous (2001) *Consumer Information*. Press release. Abuja, Nigeria: National Electric Power Authorities

Anonymous (2011). Summary, *Nigeria: Electric Power Sector Report 2011*. OliviaPhilip International Consulting Ltd. Downloaded 31 March 2011 from <http://www.reportlinker.com/p0471093/NIGERIA-Electric-Power-Sector-Report.html#ixzz1JJhyUuCg>

Bös, D. (1991). *Privatization: A theoretical treatment*. Gloucestershire, UK: Clarendon Press.

Burda, M., Wyplosz, C. (2005). *Macroeconomics: A European text*, 4<sup>th</sup> edition. Ohio, USA: Oxford University Press.

Calabrese, D. (2008). *Strategic communication for privatization, public-private partnerships, and private participation in infrastructure projects*. World Bank Working Paper no. 139. Washington DC, USA: World bank.

Dayo, F.B. (2008). *Clean energy investment in Nigeria. The domestic concept*. Winnipeg, Manitoba: International Institute for Sustainable Development. Downloaded 11 April 2011 from [http://www.iisd.org/pdf/2008/cei\\_nigeria.pdf](http://www.iisd.org/pdf/2008/cei_nigeria.pdf)

Denzin, N.K., Lincoln, Y.S. (2005). *Strategies of qualitative inquiry*, 2nd edition. North America, CA: Sage Publications.

Doody, J., Paige, J., Kiely, T., Leadman, G., Mather, S. (2010). *Corporate Nigeria: The business, trade and investment guide 2010-2011*. Publisher city, State: Corporate Guides International. Downloaded 12 April 2011 from <http://www.corporate-nigeria.com/assets/pdf/2010/cn-2010-energy.pdf>

Earl, B. (1989). *The Practice of Social Research*. 5<sup>th</sup> edition. Belmont, CA: Wadsworth Publisher.

Easterby-Smith, M., Thorpe, R., Jackson, P.R. (2008). *Management research*, 3<sup>rd</sup> edition. London, UK: Sage Publications.

- Farquharson, E., de Mästle, C.T., Yescombe, E.R., Encinas, J. (2011). *How to engage with the private sector in public-private partnership in emerging markets*. Washington DC, USA: World Bank.
- Gamst, S.B. (2008). *Wind power, political targets and policy instruments*. Master thesis, Bodø, Norway: Bodø Graduate School of Business.
- Gujba, H., Mulugetta, Y., Azapagic, A. (2011). Power generation scenarios for Nigeria: An environmental and cost assessment. *Energy Policy* 39, 968-80.
- Hamel, G., Breen, B. (2007). *The future of management*. Boston, MA: Havard Business School Press.
- Hart, C. (2005). *Doing your masters dissertation*. North America, CA: Sage Publications.
- Hydropower now and the Future 13<sup>th</sup> December 2010. (No Name) downloaded from <http://nextbigfuture.com/2010/12/hydropower-now-and-in-future.html>
- Humphreys, M., Sachs, J.D., Stieglitz, J.E. (2007). *Escaping the resources curse*. New York City, USA: Columbia University Press.
- Ikeme, J., Ebohon, O.J. (2005). Nigeria's electric power sector reform: what should form the key objectives? *Energy Policy* 33, 1213-21.
- Introduction to Arch Dams (no dates) downloaded from <http://www.dur.ac.uk/~des0www4/cal/dams/conc/concf12.htm>
- Johnsen, A.M.L. (red.) Hydropower. Downloaded 5 April 2011 from <http://www.renewable.no/sitepageview.aspx?sitePageID=1082>
- Kelly, R.A. (2007). *Energy supply and renewable resources*. New York, USA: Checkmark Book.
- Kucukali, S., Baris, K. (2009). Assessment of Small Hydropower Development in Turkey. *Energy Policy* 37, 3872-9.
- Littlechild, S. (2002) *Competition in Retail Electricity Supply*, CMI Working Paper No. 9. Washington DC, USA: World Bank.

Lukman, R. (2003). *National Energy Policy*. Abuja, Nigeria: Energy Commission of Nigeria.

Downloaded 5 April 2011 from

[http://www.energy.gov.ng/index.php?option=com\\_frontpage&Itemid=1](http://www.energy.gov.ng/index.php?option=com_frontpage&Itemid=1)

Mandil, C. (2003). *Power generation investment in electricity markets*. Paris, France: International Energy Agency.

Markey, M. (2009). Renewable Energy for the 21<sup>st</sup> Century, “Renewables 2007: Global Status Report”. Washington DC, USA: World Bank.

Methodology. Downloaded on 11<sup>th</sup> April 2011 from

<http://www.merriam-webster.com/dictionary/methodology>

Moline, A. (2010). *Answers Blowing in the Wind? Investment Challenges for Wind Development on the Lower Brule Reservation*. Master thesis, Bodø, Norway: Bodø Graduate School of Business.

New, D. (2005). Intro to Hydropower; Part 3: Power, Efficiency, Transmission and equipment selection. Feb/Mar 2005. Pp. 30-35

Newbery, D.M. (2000). *Privatization, restructuring and regulation of network utilities* (2000) Cambridge, MA: Massachusetts Institute of Technology.

Ohunakin, O.S., Ojolo, S.J., Ajayi, O.O. (2011). Small hydropower (SHP) development in Nigeria: An assessment. *Renewable and Sustainable Energy Reviews* 15, 2006-13.

Okeke, R. 14 April 2011. 100m Nigerians are without electricity, The Guardian (Nigeria).

Downloaded 21 April 2011 from

[http://www.ngrguardiannews.com/index.php?option=com\\_content&view=article&id=44789:100m-nigerians-are-without-electricity-says-bpe&catid=1:national&Itemid=559](http://www.ngrguardiannews.com/index.php?option=com_content&view=article&id=44789:100m-nigerians-are-without-electricity-says-bpe&catid=1:national&Itemid=559)

Prof Abubakar Sani Sambo (2005). *Renewable energy master plan*. Abuja, Nigeria: Energy Commission of Nigeria. Downloaded 5 April 2011 from

[http://www.energy.gov.ng/index.php?option=com\\_frontpage&Itemid=1](http://www.energy.gov.ng/index.php?option=com_frontpage&Itemid=1)

Rasmus Ole Rasmussen, Christian Dymen and Patrick Galera Lindblom (2010-2011). Nordic participation in an OECD project: The Production of Renewable Energy as a Regional Development Policy in Rural Areas. Stockholm, Sweden: Publisher name. Downloaded 27 March 2011 from <http://www.nordregio.se/?vis=sok&sokeord=hydro+power>

Rao, P.K. (2000). *Sustainable development: Economies and policy*. Maiden, MA: Blackwell Publishers.

Ristinen, R.A., Kraushaar, J.J. (2006). *Energy and the Environment*, 2<sup>nd</sup> Edition. Publisher city, State: Wiley Publication.

Robert W. Dimand and Barbara J, Spencer (2009). *History of Political Economy* (Supplement 1). Duck University Press.

Silverman, D. (2010). *Doing qualitative research*, 3<sup>rd</sup> . Publisher city, CA: Sage Publications.

Skyttner, L. (1996). *An Introduction to General System Theory: Problems, perspectives, practice* London, UK: World Scientific Publishing Company.

Social change (without date). Downloaded 11<sup>th</sup> April 2011 from  
[http://en.wikipedia.org/wiki/Social\\_change](http://en.wikipedia.org/wiki/Social_change)

Statkraft. (without date). Hydropower. Downloaded 5 April 2011 from  
<http://www.statkraft.com/energy-sources/hydropower/>

Steer, A., Stern, R., Bond, J., Watson, R. (2000). *Fuel for thought: An environmental strategy for the energy sector*. Washington DC, USA: The World Bank.

Stephen Kurczy (2010). Privatizing electricity puts Nigeria on the right track: IEA economist. Downloaded from <http://www.csmonitor.com/World/Africa/2010/0922/Privatizing-electricity-puts-Nigeria-on-the-right-track-IEA-economist>

The process how Hydropower plant works downloaded from  
[http://www1.eere.energy.gov/windandhydro/hydro\\_plant\\_types.html](http://www1.eere.energy.gov/windandhydro/hydro_plant_types.html)

Thomas, S. (2003). The Seven Brothers. *Energy Policy* 31, 393-403.

Todaro, M.P., Smith, S.C. (2006). *Economic development*, 9<sup>th</sup> edition. Ontario, Canada: Prentice Hall.

Ushigiale, J., Adedaja, T., Nzeshi, O. 5 May 2011. Obama calls, congratulates Jonathan, condemns riots. AllAfrica Global Media. Downloaded on the 7<sup>th</sup> of May 2011  
<http://allafrica.com/stories/201105050631.html>

Wangensteen, I. (2007). *Power system economics: The Nordic electricity market*. Trondheim, Norway: Tapir Academic Press.

Ward, D.R. (2002). *Water wars: Drought, flood, folly and the politics of thirst*. New York, USA: Riverhead books.

Wæringsaasen, K.T. 15 April 2011. Nordic-Nigerian cooperation in the energy sector and energy development. Royal Norwegian embassy in Abuja, Nigeria. Downloaded 5 May 2011 from [http://www.emb-norway.com.ng/News\\_and\\_events/Nordic-Nigerian-cooperation-in-the-Energy-Sector-and-Energy-Development/](http://www.emb-norway.com.ng/News_and_events/Nordic-Nigerian-cooperation-in-the-Energy-Sector-and-Energy-Development/)

Yusuf, A. 11 April 2011. Federal Government set for electricity tariff amendment. *Daily Independent news*. Downloaded 17 April 2011 from <http://www.independentngonline.com/DailyIndependent/Article.aspx?id=31921>