Determinants of Electricity Demand in Libya:

An Empirical Study for the Period 1980-2010

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PREFACE

During the process of undertaking the research a number of research posters and refereed articles were produced. They are:

Refereed journal publications

1. Elsahati, K. and Ochieng, E.G. (2014). Determinants of electricity demand in Libya: Empirical study for the period (1980-2010). Journal of Energy Policy (in preparation)
2. Elsahati, K. and Ochieng, E.G. (2014). The effect of internal and external determinants of electricity projects in Libya. Journal of Energy Policy (in preparation).

Poster presentation

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Abstract

Energy is one of the main and most important elements for achieving social and economic development throughout the world. Electricity is one of the most essential sources of energy. The importance stems from the role of electric power in fulfilling the main consumption needs for basic energy as one of the inputs to the production process. To date, the focus of the research in the field of the demand for electricity has been mainly on developed economies. Adding to the few studies carried out in the developing economies, this study has investigated the issue in the Libyan context.

This study aimed to analyse and identify the determinants or factors affecting the demand for electricity in Libya during the period 1980-2010. The study focused on the use of ordinary least square techniques, test for co-integration and Granger Causality in constructing an empirical model of the demand function for electricity. Furthermore, there was a discussion on the external and internal determinants of projects that produce electricity in Libya as examined and analysed through a questionnaire and case study method. It also adopted a validation process achieved through focus group discussion to discuss and validate the proposed framework for the organisation of electricity.

The regressions results showed that the variables the average real price of electricity demand, the real value of the imported electrical appliances, GDP, population, the temperature difference and the lagged electricity demand explained 99 per cent of the total variation in electricity demand. The price elasticity of demand and income elasticity of demand are inelastic, that means that the Libyan economy now consumes the highest amount of electricity, and electric energy in Libya is a real necessity.

Noting that the price elasticity of demand and income elasticity of demand in the long run are greater than elasticities in the short run, this means that these variables have a significant impact on the long term. According to the proposed model, the average price of electricity and the population are significant determinants of electricity demand, therefore, it implies that individuals are likely to demand electricity when the prices of electric are low, this result is confirmed from the Granger Causality results, in which it was established that a bilateral causality also exists from real values of imported electrical appliances to electricity demand and from population to electricity demand.

In regard to the supply side of electricity, the questionnaire results show that the internal determinants of electricity projects in Libya are electricity demand and political effects. The external determinants are recession, oil prices and development of other infrastructure. The development of other infrastructure was the most effective factor regarding the external determinants on the electricity projects in Libya, where the development in the residential sector has had a greater impact in increasing electricity projects during the last four decades. It is worth mentioning that the deregulation of the economy at the beginning of the nineties led to the development of the commercial sector and this in turn led to an increase in demand for electricity.

The main outcome of the validation was that the proposed framework was found practical and provided a methodology for solutions that can be taken up by the electric sector and for the government to adopt regular mechanisms to deal with the consistent upsurge in the demand and provide the basis for stable supply of electricity. The four focus groups of participants believed that energy firms in Libya and the Libyan state should take action and integrate the proposed framework. The actions are: economic planning, socio-economic development policy, development of new power plants and the expansion of the existing capacity; and improved development of other infrastructure. The increased demand of electricity in Libya compels the government, the electricity company and the other sectors of the economy to come up with a sustainable framework to meet the energy demands of the country. As established in this research, the construction of new power projects is the only long-term solution that will address the present and future energy needs.

CHAPTER ONE: INTRODUCTION TO THE RESEARCH

1.0 RESEARCH BACKGROUND

According to a 2010 World Bank estimate, 99.8 per cent of the citizens in Libya had access to energy in the form of electricity, which is the highest rate of electrification in Africa (U.S. Energy Information Administration, 2013). Energy is an important element in achieving both the social and economic wellbeing of any society. Electricity is one of the important sources of energy because development bridges energy requirement needs, especially in the production process aimed at achieving development.

In the study of economics at large, there is the conventional notion that an economy is at equilibrium or at least moving towards equilibrium (Rodrigo, 2012). With this in mind, it can be argued that the demand for electricity is directly proportional to the movement of the economy towards equilibrium. The demand for electricity remains integral for achieving the social and economic development that any society tries to accomplish. The estimation of the demand and the dynamics that affect it are thus important as they will enable those charged with framing a policy to know how to go about trying to satisfy the society's needs (Kennet, 2004). This situation is no different from that of Libya, in which, the government must know the determinants of the electricity demand to plan for both the present and the future. Furthermore, when determining the need for knowing the demand for electricity, it is important for both the Libyan government and energy firms to understand the viability of their investments, because electricity is one of the key drivers of any economy (Enerdata, 2013).

The importance of the energy sector in Libya has been recognised on numerous occasions, meaning studying the determinants of the demand for electricity is one of the drivers of a stable and viable business environment. Determining the electricity demand function in Libya makes it possible to know and evaluate the variables that influence the electricity demand, especially in the last three decades between 1980 and 2010, in part because there has never been a study to define the determinants of the demand for electricity within this specific period (Bureau of Energy Data and Studies, 2004: Energy Department, 2013). Studying these determinants followed a mode of comparison of price, income, population, temperature and appliance imports that greatly affect the demand for electricity. By having this study that conclusively looks at these determinants of electricity demand in Libya, the government and energy firms will be able to establish where to put their investments when developing electricity and the accompanying infrastructure to spur economic growth and development. From the results of this study, the government and relevant stakeholders will be able to identify areas that need to be addressed in order to make electricity available to those who need it in Libya; this will translate into greater economic growth and development.

This introduction is in six segments that highlight the research that has been undertaken. After the background statement, an appraisal of the rationale behind the research is dissected. A discussion of the study’s scope follows, then a statement and explanation of the aims and objectives of the research is done incisively and concisely.

Potential implications of the study in the real world are evaluated and discussed, after which the structure of the study is also provided.

1.1 RESEARCH QUESTIONS

This study aimed to probe to what extent population, appliance, price, income and imports act as determinants of electricity demand in Libya. It also was designed to find out how well the demand function can be evaluated to know the accuracy of the demand. The research aimed to examine how the demand function for electricity in Libya can be compared and tracked with the rates of electricity consumption in Libya. Furthermore, the study explored the performance in terms of the tracking ability of electricity consumption in terms of the empirical and econometric model. It has also identified the determinants that affect electricity projects by considering how the present electricity need impacts the Libyan economy. The research questions therefore included the following:

- How and in what magnitude do price, income, population, appliance imports and temperature affect the demand for electricity?
- How can the Libyan government improve the accuracy of the demand function in tracking realised demand?
- How can energy firms compare the tracking ability of the demand function for electricity in Libya vis-à-vis other models that purport to track the consumption of electricity in Libya?
- Does an empirical or econometric model of demand for electricity perform a better job in tracking electricity consumption in Libya?
- What are the internal/external determinants that affect electricity projects in Libya?

1.2 SCOPE

This study covered 1980 to 2010, which is the period for which data on the determinants of the electricity demand in Libya were available. Although the study is based mainly on the construction of the econometric model of the consumption of electricity hinged on the demand function, an assessment of the tracking ability of this model was made with a comparison to alternative models (Mbendi, 2005). These studies also attempted to assess the implications of the policy's findings; for example, the implications on production, planning and the prospects of using renewable energy sources, amongst others. The scope has been limited to this time period because it heralds the discovery of new energy sources for Libya through oil wells as well as the country's exportation of natural gas, this period also shows a time when Libya has developed other sources of renewable energy, such as constructing wind farms and tapping into solar power. It is worth mentioning that during this period, Libya has gone through a tremendous population growth that clearly shows that the demand for electricity has to change (Enerdata, 2013). Furthermore, this period shows a time when the political and economic situation of Libya was stable compared to the situation after the revolution of February 2011, which is characterised by instability and lack of security in the country (World Bank 2012).

1.3 THE AIM AND OBJECTIVES

This research aimed to examine and identify key determinants affecting the demand for electricity in Libya by taking into account the current need to understand how major electricity projects can impact the economy. The main objectives as framed were as follows:

1. Review the current practice in the Libyan energy sector and compare this to that of the United Kingdom;
2. Identify factors contributing to the econometric framework of demand function for electricity in Libya;
3. Compare the tracking ability of the demand for electricity model with other models that can be developed for Libya;
4. Examine the effect of internal/external determinants of electricity projects in Libya; and
5. Propose a framework for electricity organisations in Libya.

In the analysis of the first objective, a thorough review was undertaken using the descriptive analysis method of the present application in the Libyan energy division compared with the situation in the United Kingdom. The second objective was achieved through a complete dissection of the determinants that affect the demand for electricity in Libya. This was achieved through information collected in time series data and has been analysed through different statistical methods which include OLS regression and test for co-integration. Granger Causality was used to evaluate the third objective by comparing the tracking capability of the electricity demand with other models developed specifically for Libya. The fourth objective examined the internal and external determinants of electricity demand in Libya and was achieved by a thorough investigation and further analysed by a survey conducted via a questionnaire and a case study. The validation methodology was used to achieve the final objective by discussing and validating the proposed framework for electricity organisation.

1.4 RESEARCH METHOD

The study adopted both qualitative and quantitative methods which have been used as vehicles in the collection and analysis of data. This study examined factors that dictate the electricity demand in Libya and used ordinary least-squares (OLS) techniques and test for co-integration and Granger Causality in constructing an empirical model of the demand function for electricity. Furthermore, there is a discussion on the external and internal determinants of projects that produce electricity in Libya as analysed through a questionnaire and a case study method. It also uses a validation process achieved through focus group discussion (FGD) to validate the results of the study and the proposed framework for Electricity Organisation.

1.5 THE MAIN FINDINGS AND POTENTIAL IMPLICATIONS

The demand for electricity in Libya has grown rapidly, and a number of economic and noneconomic factors account for this growth. Results of the study show that the variables the average real price of electricity demand, the real value of the imported electrical appliances, GDP, population, the temperature difference and the lagged electricity demand explain 99 per cent of the total variation in electricity demand. The price elasticity of demand and income elasticity of demand are inelastic in both short run and long run, that is mean the Libyan economy now consume the amount of high electricity and the electric energy in Libya is real necessity. The increased demand for electricity in Libya compels the government, the electricity company and the other sectors of the economy to come up with a sustainable framework to meet the energy demands of the country.

The potential implications of this research are that future researchers will be able to use it as a reference point for studies that discuss the determinants of electricity demand in Libya. While acting as a reference point, the study also has the potential for stimulating the interests of academics and rousing interest in research on electricity and other sources of alternative energy, such as renewable energy sources (solar and wind energy). The study is important for both the Libyan government and other stakeholders in the energy sector to frame policies that touch on how to manage the demand for energy vis-à-vis the supply. This study used econometrics model that in turn uses the OLS technique and compares the results with the Granger Causality model.

Statistics show that the generation of electricity has doubled between 2000 and 2010, and the increased demand has outgrown the installed generation capacity, leading to an inability of energy providers to serve the consumers' demand for electric power (Mbendi, 2005). This study has the potential for making the concerned authorities understand that power interruptions in the energy sector compromise the production on the oil fields and ultimately affects electricity demand in Libya. As established in this study, despite the higher electrification rate in Libya, there are still numerous outages occasioned by inadequate supplies of electricity.

However, this study also confirmed that because of increased electricity generation, there has been increased economic growth that has positively impacted on the oil and natural gas sectors. This has occurred against a backdrop of increased demand that at times leads to power shortfalls as the demand outstrips the power supply. This study shows that Libya's installed power supply in 2010 was mainly from power plants primarily fuelled by oil or natural gas that are relatively expensive. This information has encouraged the government of Libya’s effort to move towards renewable sources of energy such as the construction of wind energy plants (Saleh, 2006) and solar projects, especially, in remote parts of the country. From this study, it can be deduced that despite the positive outlooks and the ambitious plans by the Libyan government to satisfy the electricity demand in Libya, there are still challenges that affect the energy sector. There is the threat of power disruption caused by the destruction of power transmission lines; this causes price increases for electricity power that are transmitted to the consumers to cover the costs of repair.

The study also shows to a small extent that disruptions in the electricity supply are at times caused by breakdowns or a damaged infrastructure that requires a new capacity for generating electricity to be installed to meet the growing electricity demand. It is worth mentioning that Libya needs to adopt measures to conserve energy and use alternative sources that can enhance production of the energy required for economic development. In addition, the need to make efforts to frame a coherent energy policy that concentrates on renewable energy infrastructure and accompanying projects is discussed in this study.

A potential implication of this study is to realise that the causes for shortfall by the energy provider to meet the demand for electricity is the insufficient generating capacity, failures of the transmission system and disruption of power distribution. These technical challenges are compounded by failures in information system management as well as forecasting and future planning on ways to meet the demand for electricity. A second potential implication of this study is to realise that the policies for meeting the electricity demand in Libya should focus on bridging the competitive gap between renewable sources of energy and traditional sources of energy through measures such as transferring subsidies to producers. This is based on the fact that investing in sustainable energy technologies ensures a steady and secure supply of energy for present and future use that has long-term social, economic and environmental benefits.

Thirdly, this study also shows that the impact of supply disruption of Libyan electricity will be affected by the underlying market conditions such as the balance between demand and supply and the capacity for electricity production and transportation. There are implications for electricity demand, especially costs related to appliances which include the initial costs of accessing electricity; for example, the infrastructure costs as well as the costs of buying the appliances that use the electricity. Costs associated with redundancy may include the initial cost as well as the fact that most appliances are designed before electricity is connected. This greatly affects demand for the electricity in both Libya and other third world countries that are trying to be connected using some form of electric power (Louw *et al.,* 2008).

This study also reaffirmed that income plays a significant role in affecting the electricity demand in any household in this case, Libya, and therefore, those charged with pricing this commodity must consider the price they put on the electricity. This may be made easier by increasing access to credit or having alternative ownership mechanisms for electricity for all households in Libya.

1.6 STRUCTURE OF THE THESIS

The second chapter reviewed the entire energy sector in Libya. This entailed an introduction which explains the concept of energy and energy sources, with Libya as the point of reference. The research further discussed the role of energy and its sources in the Libyan economy. There is a discussion on the evolution reserves of oil and natural gas in Libya and other sources of energy and their development and production. That discussion also involves the development of electric power in Libya with an analysis of the power plants, transport, distribution networks and the electric projects in Libya. In addition, the chapter compares the present energy application practices in Libya with the energy sector in the United Kingdom.

The third chapter discussed the demand for electric power in the economic literature and includes the inherent characteristics of electric power and the determinants of electric power in Libya, including the roles played by income, imported appliances, population growth and economic growth. The electricity industry in Libya and the factors that affect it such as government policies, pricing, lifestyle and political factors are also discussed.

The fourth chapter discusses the research method that incorporated the economic theories and methods of electricity demand, the research techniques, methods and questions. The quantitative methods of the study evaluated the OLS regression methods and its assumptions, including the advantages and disadvantages. The multiple OLS regression, test for cointegration and Granger Causality were tested. This chapter also includes the research design, sample design, recruitment of participants, questionnaires and data analysis and verification and validation of the data and results.

The fifth chapter estimates the demand function of electricity through the quantitative method and its findings. It also includes a correlation and model-specific tests as well as the test of heteroscedasticity and the Durbin H test for autocorrelation. It also includes Granger Causality tests (cointegration results) and the regression results, including *t*-tests for significance of the predictors and F-test for overall significance. This chapter also discusses the determination of the elasticities of demand for electricity and the demand function estimates.

The sixth chapter discusses the effect of internal and external determinants of electricity projects in Libya using qualitative methods. The study of the internal determinants of electricity projects in Libya includes electricity demand, the political effects and tariffs are presented. Also, there is a discussion of the external determinants, including recession, effects of oil prices and improved infrastructure.

The seventh chapter provides a description of the proposed framework for electricity organisations in Libya. It includes how the validation of the proposed framework through the focus groups discussions was carried out to find the views of the participants on the components of the framework. This chapter also discusses the findings from the validation process and appropriateness of the proposed framework in real life scenarios.

Chapter eight is the final chapter, which includes a discussion of the results, presenting the limitations of this study and highlighting a number of recommendations for future research purposes. Figure 1.1 presents an overview of the eight chapters.

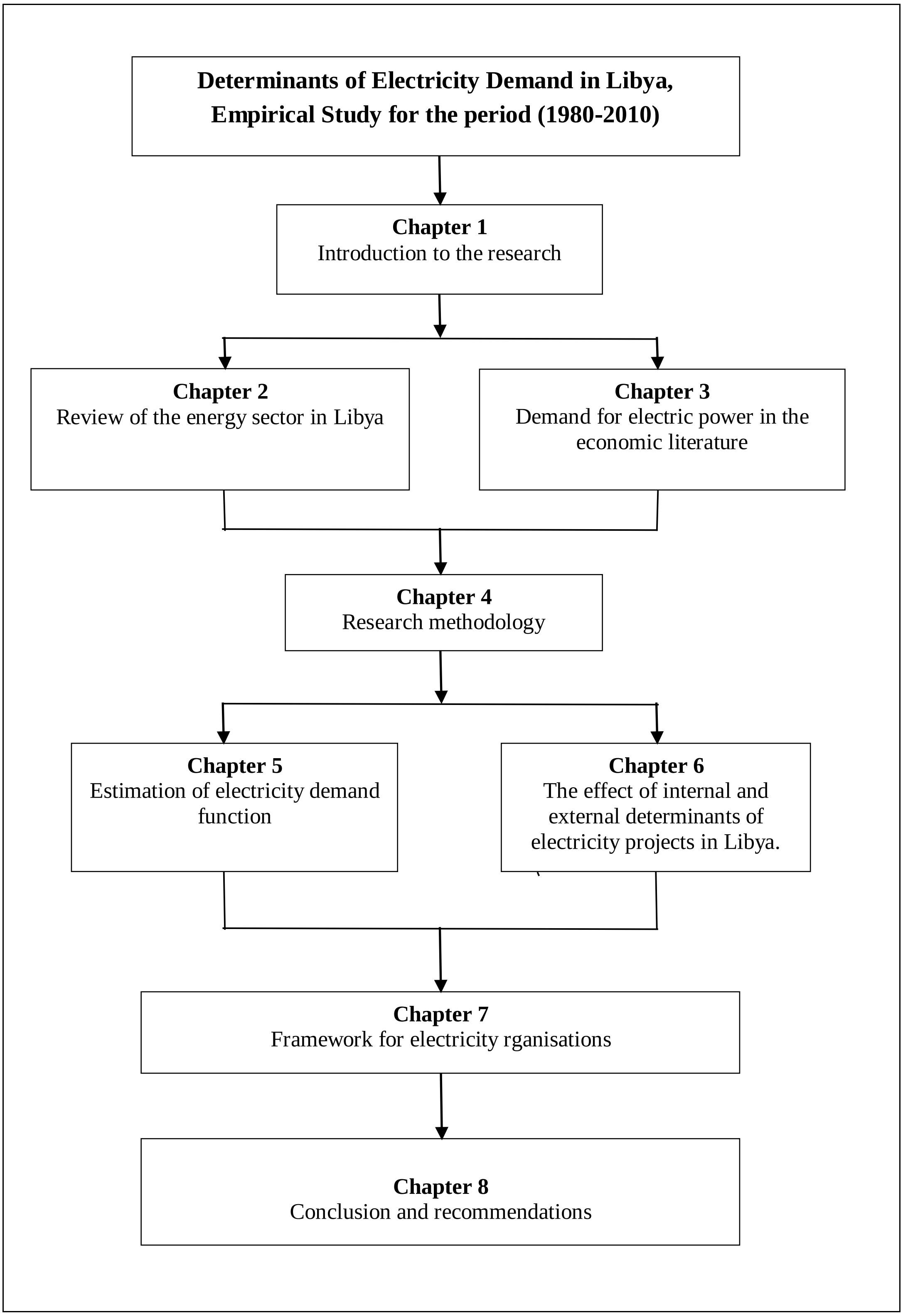


Figure 1.1: Overview of chapters

CHAPTER TWO: REVIEW OF THE ENERGY SECTOR IN LIBYA

2.0 INTRODUCTION

This chapter introduces the background about Libya as a country and highlights the main characteristics of the Libyan environment, social, economic and political. Also, the chapter deals with the concept of energy statement, and identifies their sources, and role in the Libyan economy, and analyses the evolution of these sources during the period (1980-2010). Additionally, it reviews current practices in the Libyan energy sector and compares this to the UK.

2.1 LIBYA AS A COUNTRY

Libya is a typical example of a developing country, the vast majority of the country's population professing the Islamic religion and speaking Arabic (Daft and Marcic, 2013). The land area of the country is 700,000 sq mi, Libya is fourth in size among the countries of Africa and seventeenth among the countries of the world. The Mediterranean coast and the Sahara Desert are the country's most prominent natural features and the country is mostly covered by the Sahara Desert. The only exception is the narrow 1,200 mile coastline bordering the Mediterranean Sea where almost 80 per cent of its population resides. The dominant climatic influences are Mediterranean and Saharan with hot summers and mild winters, rainfall is scanty.

The country's geographical location is between 32° N and 52° N and between 13° E and 11° E in the North of Africa and it borders various nations, including Egypt in the

East, Chad, Niger, and Sudan in the southern borders, and Algeria and Tunisia in the West and North West regions respectively (Worldatlas, 2014). Figure 2.1 represents Libya's geographical outlook.

Figure 2.1: Map of Libya

Source: http://www.worldatlas.com/webimage/countrys/africa/lgcolor/lycolor.htm
Accessed on: 16th May 2014

Libya is a desert economy with most of its vast oil mining projects in the desert. Chronological accounts documented by historians indicate Libya as a renowned country with an abundant ancient history. Libya’s economy was a force to reckon with in a two-decade period, but collapsed in early 2011. Before Libya's independence, Libya had been a colony of various European nations, for example, Byzantine and Ottoman empires and in modern times it was occupied by the British, French and Italians (World Bank 2012). The Italians arrived in 1911 and remained for about 30 years. It was in 1934 that the name "Libya" was officially adopted for the region. Thereafter, Libya gained independence in 1951 through the efforts of Iddris who later on became the king (World Bank 2012). However, his leadership was short-lived as it was by toppled Muammar Gaddafi's coup. Gaddafi served as a leader since his service led to the country's development as an oil mining economy (World Bank 2012). Furthermore, he served for a 42-year-old regime in stringent political regulations.

Prior to the coup that ended Gaddafi's rule in Libya, the country's gross domestic product (GDP) ranked fifth in the African region. However, it is only in the year 2011 that Libya gained a democratic state following a six-month uprising that toppled Colonel Muammar Gaddafi's 42-year-old government. The country's capital city is Tripoli and the census indicates it as a habitat to 1.7 million Libyans out of the overall 6.4 million people (Armstrong, 2008). Despite the country having gained independence in 1951, Libya depended heavily on its oil deposits to improve its then insignificant economy to the current renowned state.

In Libya most regions bear unexploited oil deposits. The country's economic advantages seem unending since it borders the Mediterranean Sea at its Northern part, which provides the best utilities for refineries and maritime services (World Bank 2012). The exploration and mining of oil and natural gas resources have enabled Libya to improve the standards of living of its people. The oil and natural gas resources solved energy and electricity problems; thus, by the end of 2012, the country was yet to engage in the use of renewable energy sources (World Bank 2012).

2.1.1 Society in Libya

Libya comprises of various ethnic groups that include the Arabs and Arab Berbers, the Tuareg, and the Tebou. These communities inhabit different parts of the country.

Notably, the groups inhabit the regions of Tripolitania, Fezzan, and Cyrenaica respectively. In 1959, oil reserves were discovered, and the income generated from petroleum sales pushed Libya into an extremely wealthy state (World Bank 2012). Oil wealth led to changes in the society which had converted the country from one of the world's poorest to one of the most prosperous. Most Libyans enjoyed educational opportunities, and health care which were free. Life expectancy, perhaps the ultimate measure of living standards, had lengthened by ten years since 1960 (World Bank 2012).

Since independence, Libyan leaders have been committed to improving the condition of women but within the framework of Arabic and Islamic values. In the 1970s, the status of women had then become the subject of a great deal of discussion and legal action in Libya for female emancipation followed, because the state viewed women as an essential source of labour in an economy for workers (Daft and Marcic, 2013). The status of women continued to undergo modification at the behest of the government. Especially in urban areas, women in ever- greater numbers were entering schools and the universities and finding employment in professions newly opened to them. Although tradition remained quite strong, the role of women was in the midst of what was for Libya a remarkable transformation, and social mobility was much improved (Daft and Marcic, 2013). The social practices of the country depict that the country underwent a series of social changes in the 1980s. Through the influence of the former leader, Muammar Gaddafi, Libya’s underdeveloped state transformed gradually towards achieving a contented society (Daft and Marcic, 2013).

However, the birth of an egalitarian socialist society in Libya stirred mixed reactions and led to the formation of rival groups. Despite the dissidents' pursuance of power and restoration of the ancient societal norms, the regime's constitution allowed the leader to execute the discontented parties. The socialist policy of Libya was affair to the extent that the country avoided involvement with other capitalist nations whilst possessing control over oil trade affairs (Armstrong, 2008). The societal practices led to the prevalence of unjust policies as the people were deterred from engaging in activities that would help reshape the country. Furthermore, the government proposed incentives to improve living standards and thus, by 1985, Libya was an economically sound nation with its entire people living in better living conditions. The new regime proposed for the increased birth rate and in the late 1980s, the country's rate of population growth hit 4 per cent (Armstrong, 2008).

These social practices were well received by the leaders of the nation who lived amongst the Tripoli and Benghazi communities since they recognised this as the ultimate government. Education, hospital, and other social amenities were provided for the people freely, a factor that served to increase lifespan and literacy levels in the country (World Bank, 2012).

2.1.2 Socio-economic development

The country of Libya lacks agricultural land because of the geographical location and the presence of deserts. This aspect hinders creation of new job opportunities through the agricultural sector as the country lacks farming land. The economic situation of Libya, thus, offers opportunities to the citizens through the industrial sector (Armstrong, 2008).

The country owns a vast wealth in fossil oil composites and to that extent strives to achieve full rates of employment among the citizens. For example, economists argue on the subject of unemployment as relative to production factors. The following context establishes discussions and analytical approaches to the various aspects surrounding unemployment, with a precise survey of the world economic crunch problems and the subsequent approaches to reshaping the country's unemployment (Daft and Marcic, 2013).

Since the year 2002, the economy of Libya witnessed a slight increase in the rate of unemployment at a level of 1.3 per cent. This was alarming to the country due to its 9 per cent growth in population, and the increment in the population of the learned elite. However, the country's crude wealth realised and recovered the deficit to a rate 1.2 per cent in the unemployment levels (Economic and Social Commission for Western Asia, 2007). Predictions of a continuous rate of reduced unemployment among the citizens seemed unending. However, the Libyan society was discontented by the government's continuous inclusion of women in jobs that differed from the customs and traditions (Economic and Social Commission for Western Asia, 2007).

2.1.3 Social context and human development

The Muslim country of Libya approaches the issue of gender as influential to economic growth. For example, economists argue that women could play a vital role in reshaping the unemployment levels. With abundant oil deposits, the country reduced the poverty levels, and this led to an increment in population alongside improved standards of living. The emphases are that women shall stay home and take care of all odd jobs, thus eradicating the need for foreigners to undertake those jobs (Armstrong, 2008).

The economists argue that importation of labour into the country leads to a reduction in the foreign exchange revenue. They further derive that the economy relies on imported commodities, and importation of unnecessary labour implicates on increased incompetence in the foreign trade (Armstrong, 2008).

The age differences establish a similar finding that the youths between the ages of 20-24 are the most affected by unemployment levels in the country (Daft and Marcic, 2013). The unemployment rates seem to reflect a higher percentage towards women than the men, at 78 percent and 22 percent respectively (Daft and Marcic, 2013). However, economists reflect the men as the most affected by the situation since the Islamic nations see them as family heads and joblessness shall lead to generalised poverty in the country. The male gender at the youthful ages of 20-24 establishes a different figure of 1856 jobless individuals among the male population. It is the highest male population count of the unemployed (Armstrong, 2008). Therefore, Libya's socio-economic and human development remains abundant despite the political crisis witnessed in its environment since 2011.

2.1.4 Policy issues relating to energy

Anticipations of Libya’s economic advisers concerned with all energy producing utilities are that the country would recover the non-renewable energy through the implementation of eco-friendly energy production policies. For example, they derived an understanding that the country’s crude reserves were instrumental in reshaping the country’s energy demand levels through an increase in the usage of renewable energy sources. The country’s energy production rates were influential towards increments in GDP and GNP as Libya ranked the tenth global producer of energy in 2008 (Daft and

Marcic, 2013). Increased demands of the scarce product of the economy led to the intensified exploration and the mining of oil. The main importers of the country's oil were Italy, China, Yemen, Sudan, U.S, and Egypt amongst other African economies. Libya's exportation of oil grew autonomously as the global fuel prices escalated profusely (World Bank, 2012).

Currently, energy in the country is implicit to economic growth rates since its oil exports meet 78 per cent of the European energy demands. In the long run, Libya increased its domestic consumption levels of renewable energy and increased exportation of non-renewable energy in the context of crude oil and natural gas. These practices reflected increments of 1.7 per cent and 2.1 per cent respectively from 2008 to the first quarter of 2013 (Economic and Social Commission for Western Asia, 2007). These energy consumption and production affected the country's energy capacity of production and the overall production (Economic and Social Commission for Western Asia, 2007). Furthermore, the country's economic welfare improved despite its tenth position in energy production. The significance of energy in an economy such as Libya is the ideology of enhanced economic production as the earnings from the exports are likely to be spent on projects that would lead to enhanced economic progression (World Bank, 2012).

2.1.5 Macroeconomic policy

The study establishes the findings based on the cumulative macroeconomic approaches in Libya. With a population tally exceeding 6 million people, the country has been in the lead in the grand GDP for many years (Economic and Social Commission for Western Asia, 2007). Mainly, its oil resources exceed the local demand needs and thus, its exports are overwhelming and certainly incremental to the country's competence against other foreign society (Economic and Social Commission for Western Asia, 2007).

For instance, the statistics show that the country's GDP and per capita growth stood at 4.8 percent, making Libya the fifth nation in Africa with substantial economic growth (World Bank, 2012). Furthermore, in the year 2011, unemployment reduced in both men and women by 47.91 percent to establish an outcome of 54.55 percent. Cumulative statistics in the unemployment bracket seem to show a reduction in the poverty levels (Druskat and Wolff, 2004). The Libya macroeconomic statistics on unemployment levels show that the different industrial and mining programs are of importance while focusing to derive an approach towards resolving the problem of unemployment and the threat of future uncertainties in the country's economy (World Bank, 2012).

They implied that the foreign exchange advantage would lead to an increase in the GDP and per capita incomes. Youths are intrinsic in innovation and stimulation of Libya's economy towards the desired economic levels (Economic and Social Commission for Western Asia, 2007). Despite all these variables, the youths at the ages of 20-24 derive the highest number of jobs for the 2011 and 2012 respectively. The government's economic prospects seem to reflect on the population as vital in the development of businesses through upholding the importance. This would to the immediate increased employment rates (Daft and Marcic, 2013).

However, the increase in the crude oil prices, which coincided with the 2008 economic crunch that propelled inflation of the dollar and further to the foreign exchange markets where the dollar rules as an exchange medium, was incremental to the country's economic situation. The employment rates in the country increased in both the short run and long run, hence ensuring certainty in GDP growth, in the forthcoming years (World Bank 2012). The increment of employment reflected the urge for economic growth through increased rate of transacting crude in accordance with the Arab League practices.

2.1.6 Economic and political governance

Libya's economic and political governance implements a system of nationalism since the authorities have controlled a major stake of the country's resources in the past. The positive reflection on the level of governance despite being a dictatorial regime preserves an equal reflection that the country was successful (Economic and Social Commission for Western Asia, 2007). These political and economic changes led to the needs for skills and competence as the population increased accordingly. The majority of Libyans have higher education certificates. These indications reveal that the country's economic growth is certainly likely to increase rather than decrease. The cumulative findings establish that the political unrest that transpired early in 2011, and six months later as a cause to increased unemployment rates for both genders. Technology has continually reflected in increased economic performance through intensified production and improved output (Economic and Social Commission for Western Asia, 2007). This could further implicate on the need for education skills in the citizens of a country. The country that encourages education shall derive the desired value of economic performance to an enhanced gross domestic product and incomes per head.

Perceptions of the intense relevance of reduced taxation towards the levels of unemployment reflect towards either increased investments or more employees in the country’s industries (Armstrong, 2008). Economists argue out that the dawning importance of a cohesive political and economic situation is innate to the increased rate of Libya’s competence in Africa (World Bank, 2012). Through the economy, tasks achieved technological simplifications, which implicated to eradication of foreign workforce since the local population was knowledgeable the requirements of running the different machineries (Daft and Marcic, 2013). At this point, Libya renders other African economies too redundant with their unemployment rates are still wanting. Arguably, the country's income in the presence of reduced employment reflects positively to Libya’s quality of oil production. However, the country’s statistics reveal a decrease on the access to high school education with men representing a rate of 6.38 per cent. Analyses are that, the men reflect a reduction in accessing education with the ability to acquire informal employment (World Bank, 2012).

2.1.7 Conflict devastates the economy

Violent protests in Libya erupted on February 17, 2011, escalating rapidly into conflict, following the continued mixed reaction amongst the population from the different regions of the country. A well-organised Muslim population with the ideals of the Islamic faith was able to overthrow Muammar's regime holding that the government’s practices differed from those of the religion (Armstrong, 2008). The Libyan civil war erupted alongside that of Tunisia, Egypt, and Syria. The revolt showed that there was no person worth of ruling a Muslim nation for an indefinite period. After several months of civil war, the country's dissidents formed alliances with all NATO allies and engaged them in a fight against all the opposing groups of people (Daft and Marcic, 2013).

As a consequence of the conflict, crude oil production fell to 22,000 barrels per day in July 2011, although output was restored rapidly in the last quarter of 2011 to half the pre-conflict level. Non-hydrocarbon economic activities were affected adversely by the war due to the destruction of infrastructure and production facilities, disruptions to banking activity, limited access to foreign exchange and the departure of expatriate workers (Chami *et al.*,2012). Consequently, with an estimated 50 per cent contraction in non-hydrocarbon output, the total real GDP in 2011 was 60 per cent lower than in 2010 (Chami *et al.*,2012).

By September 2012, Libya's economic activity began to recover thanks to the nearly full resumption of oil production, an increase in construction and infrastructure activity, and the prospects of reduced political instability, this component was expected to recover by 2014, driven mainly by reconstruction. The political volatilities surrounding an increase in domestic security incidents affecting the army and civilians, the absence of law in light of the interim government and the proliferation of armed militias and trapping oil fields, have acted as obstacles to a recovery and delayed long-term economic planning (World Bank, 2014). Therefore, Libya's economy was slowly converted from the socialist state to the capitalist state it is in the present.

The studies depict that the country's economy slumped with time and currently, Libya suffers with increased unemployment rates, poverty, and industrial malfunction. In the civilised economies, labour changes in accordance with the changes in other production factors (Economic and Social Commission for Western Asia, 2007).

However, the Libyan urban population seems since Libya's past leadership has always set educational and job opportunities for those in the urban areas. Therefore, the political unrest resulted in increased differences amongst the population, which translated to a slump in the GDP (World Bank 2012). The country's economic performance and reduction of unemployment levels, and of the future of the Libyan economy after the revolution, there is not yet a clear vision.

2.2 THE CONCEPT OF ENERGY

The general concept of energy is "the ability to do the thing" (Al Khouli, 1997), and what is scientifically known as energy is something that has the power on potential to complete the work or job; and within this term, two types of energy are the main ones. The first is energy initial; these are primarily energies, such as thermal energy (volcanic and geothermal land), light energy (solar energy), chemical (coal, oil and natural gas), and mechanical (wind, wave and tidal). The second is energy secondary; produced using the primary energies, which are electrical, thermal or photonic (Al Khouli, 1997).

The energy occurs naturally from the sun and stars and in synthetic forms, whereby, the radioactive, active composites react to produce energy and gaseous emissions. Most of the world's renewable energy sources are hydroelectric power sources and solar energy sources (Daft and Marcic, 2013). However, wind is also an incremental source of energy since it is salient to the propulsion of wind turbines that are capable of producing a lot of energy (Daft and Marcic, 2013). The use of nuclear energy is a vital solution for growth in modern economies. However, the credibility of how the production of nuclear energy serves the good purpose of the world remains questionable. Over the past five decades, the country's dependence on energy from oil reduced substantially, but most of its utilities needed the non-renewable energy products to run. Technological advances in energy production took a new course, with superpower countries sharing nuclear information under questionable circumstances (World Bank, 2012).

Although emphasising a controlled system of management for the energy technology, different countries in the global society perceive the technology from a different perspective as to the implementation of the processing nuclear power. Studies on the sharing of energy technology among the allied and powerful nations implied that the purpose was more than producing domestic energy (United Nations and United Nations Conference on Trade and Development, 2010). The result is that most world economies would perceive nuclear energy usage from a controversial stance for its positive and negative developments (Armstrong, 2008). Some countries aim to improve on their energy production, thus choosing to set up nuclear reactors, while other nations decline on the projects of nuclear reactors for political reasons. Israel invented nuclear energy and shared it with America, France and other capitalist countries. Nations that gain access to all types of energy production, including geothermal power are capable of advancing in technology (World Bank 2012).

2.3 SOURCES OF ENERGY

Although all types of fuel are the sources of energy, but not all sources of energy are fuel. It is here the distinction between the fuel and energy resources, for example, the coal is a source of energy and it burns to produces heat energy can be converted into electrical energy or mechanical, for this the coal is a fuel. The watershed is a source of potential energy that can be obtained by exploiting the difference in water level for power generation, for this a fuel had fired on energy sources, which includes wood, coal, vegetable and alcohol, oil, natural gas and nuclear fuel (El Montasser *et al.*, 1992). Sources of energy can be divided into two (Al Khouli, 1997):

2.3.1 Non-renewable sources of energy

Include chemical fuel types (oil, natural gas, coal) and nuclear fuel, these are sources depletes its reserves on an ongoing basis as a result of exploitation, and its diminishing reserves are on which the rate of annual production of these sources in the world, and the rate of discovery of new reserves of them (Al Khouli, 1997).

Apparently, statistics depict that nuclear weapons would cause devastating destruction of the ecosystem. The use of non-renewable energy in the world diversified and intensified from the production of electricity to production of weapons of mass destruction. For instance, the nuclear used in nuclear centrifuges have been used to produce these weapons. Crude oil, coal, and uranium represent a larger percentage of non-renewable energy sources. Consequently, these sources may cause destruction over a long period to the surroundings, due to the poisonous gas emissions and the side effects created by the actual products to the environment (Druskat and Wolff, 2004).

Scientific studies depict that the production of nuclear energy, being a non-renewable source could pose devastating consequences for the world, not only in the possible destruction that the weapons may cause, but also in global warming from the isotopic compound emissions emanating from the production plants' centrifuges (Gibson and Vermeulen, 2003).

The forecasted implications on energy demand levels against the level of production further dictates the country's need for the nuclear energy production to solve the threat of unemployment that is likely to occur (Daft and Marcic, 2013). The population may perceive a threat as the indulgence of the country in the use of non-renewable energy as something which threatens their health due to the high levels of carbon dioxide emissions.

2.3.2 Renewable energy sources

Renewable energy includes solar energy, energy generated from wind, waterfalls and ocean wave, geothermal, and fuels of plant origin such as wood; the source does not diminish its reserves by continued exploitation. Excluded from this definition are fuels of a plant origin, but provided the rate of exploitation is no more than the natural rate of renewal of this source (Al Khouli, 1997).

Renewable energy production in the world is likely to reflect increased incomes as the educated individuals aim at tapping solar energy for use in the domestic sector (Beatty and Scott, 2005). The studies reflect the practice as likely to lead to employment, and the casual labourers as likely to earn a wage of $27 while their professional counterparts establish salaries of at least $10,000 a month. Renewable energy systems lead to reducing the levels of environmental pollution in every global economy and society (Devlin, 2010). Renewable energy depicts the use of energy production utilities that cannot be exploited and are not harmful to the environment.

Through renewable energy production, individuals will earn competences for labour needs, as they rival each other towards common interests (Daft and Marcic, 2013). However, energy production results in specialisation and division of needs since some parts of the population may not accept the changes towards the use of renewable energy and will thus continue to use energy sourced from non-renewable sources (Rojewski, 2004).

2.4 THE ROLE OF ENERGY SOURCES IN THE LIBYAN ECONOMY

The Libyan economy suffered during the period of the fifties from backwardness and disability; poverty and unemployment were the most important attributes and features of that period, but the economic and social situation of the country soon changed following the discovery of oil in commercial quantities after 1959 and the start of exports at the beginning of the sixties. Thus the Libya economy changed during the sixties from a backward economy dependent on agriculture to a development economy. The period saw a significant increase in the average per capita income, providing sufficient capital to finance development projects to build economic and social sectors (Ministry of Planning and Development, 1962). Table 2.1 illustrates the evolution of real Gross Domestic Product GDP in different economic sectors during the period (1962-2010) at constant prices of 1997.

Table 2.1: Evolution of real Gross Domestic Product GDP during the period (1962-2002) at constant prices of 1997. Libyan Dinar LD Million

Year	Oil and gas sector	%	Agriculture sector	%	Industry sector	%	Other sectors	%	GDP	%
1962	775.5	38.4	184	9.1	34.7	1.7	1025.3	50.8	2019.5	100
1965	4287.3	55.6	244.7	3.2	43.2	0.5	3113.9	40.7	7689.1	100
1970	10834.7	58.9	183.9	1	71.6	0.4	7314.1	39.7	18404.3	100
1975	3994	42.2	414.5	4.4	146.3	1.5	4915	51.9	9469.8	100
1980	4943.7	41.6	752.9	6.3	361.4	3	5813.5	49.1	11871.5	100
1985	3314.8	33.5	940.1	9.5	670.4	6.8	4964	50.2	9889.3	100
1990	4059.8	35	1136.2	9.8	802.1	6.9	5600.9	48.3	11599	100
1995	4465	34.1	1175.6	9	905.9	6.9	6564.4	50	13110.9	100
2000	4255.2	29.4	1274.6	8.8	1049.3	7.3	7872.4	54.5	14451.5	100
2005	6030.6	28.2	1347.8	6.3	4732.9	22.1	9254.5	43.3	21365.8	100
2010	5714.2	21.3	2011.3	7.5	3343.1	12.5	15706.8	58.7	26775.4	100

Source: - see Appendix C (*The percentages discussed in Table 2.1 have been generated from appendix C*).

The table shows the high contribution of the oil and gas sector to GDP during the period of the sixties, and the low contribution of other sectors which characterised this period. The dominance of the oil and gas sector, with the percentage of its contribution to GDP to 55.6 per cent in 1965, increased to 58.9 per cent in 1970, largely because of the decline in the contribution of the agricultural sector and the industrial sector during this period. There were several reasons including the failure of these sectors on the one hand and the increasing importance of the oil sector on the other hand, which led to the migration of labour from traditional sectors of agriculture and industry to the oil and gas sector, and to the service sector, which began to grow (Attiga, 1987). During the period (1970-1997) development plans and budgets spotted and executed large investments amounted to 36.8 billion dinars. (General People's Committee for Planning, 1998)

2.4.1 Evolution reserves of oil and natural gas

Libya is a member of the Organisation of Petroleum Exporting Countries (OPEC), the holder of Africa's largest proven oil reserves, and among the ten largest globally (U.S Energy information administration 2012). It is worth noting that Libya is an important exporter of oil and natural gas. Libyan oil is generally light (high API gravity) and sweet (low sulphur content). Close to 80 per cent of Libya's proven oil reserves are located in the eastern Sirte basin, which also accounts for most of the country's oil output (U.S Energy information administration 2012).

Libya has actively seismic activity and exploratory drilling, these activities are the most important methods to increase reserves of oil and natural gas, and as a result of these activities many oil and natural gas field have been discovered and developed. Perhaps the most important of these discoveries is the Bouri oil field, the largest offshore field in the Mediterranean , it covers an area of (33) miles in length and (10) miles in width, and field contains two billion barrels of reserves extracted (Union of Arab Chambers. 1998). According to Organisation of Arab Petroleum Exporting Countries (OAPEC), Libya had total proven oil reserves of 47.1 billion barrels and natural gas reserves estimated (1495) billion cubic meters. During the period 1980-2010 exploration activity has led to discovery of ninety-one oil fields and forty-six gas fields (Organisation of Arab Petroleum Exporting Countries, 2010).

Table 2.2 shows the evolution of exploration activity which contributed to the development of reserves of oil and natural gas during the period (1980-2010), with an estimated oil reserves of about (47.1) billion barrels, and natural gas reserves estimated at (1495) billion cubic meters.

Table 2.2: The development of oil reserves, natural gas and Oil discoveries during the period (1980-2010)

Year	Crude oil reserves (Billion barrels at the end of the year)	Natural gas reserves (Billion cubic meters at the end of the year)	Oil discoveries	Gas discoveries
1980	23	674	1	1
1981	22.6	657	0	0
1982	21.5	609	1	0
1983	21.3	604	2	6
1984	21.2	601	2	3
1985	21.3	606	1	1
1986	21.3	728	2	0
1987	21.0	728	5	0
1988	21.0	728	4	2
1989	22.8	722	3	3
1990	45.0	1218	4	0
1991	45.0	1218	6	1
1992	45.0	1270	6	7
1993	45.0	1297	11	4
1994	45.0	1310	14	7
1995	45.0	1313	9	8
1996	45.0	1311	3	0
1997	45.0	1315	2	1
1998	29.56	1313	7	1
1999	29.50	1214	2	0
2000	36.00	1374	1	1
2001	36.00	1314	2	0
2002	36.00	1314	3	0
2003	39.10	1491	4	0
2004	39.10	1491	0	0
2005	41.50	1491	2	0
2006	41.50	1420	7	3
2007	43.70	1540	5	2
2008	44.30	1540	8	0
2009	46.42	1549	6	0
2010	47.10	1495	6	1

Source:

1- Organisation of Arab Petroleum Exporting Countries (OAPEC), the Secretary-General's annual report, various issues.

2- Organisation of Arab Petroleum Exporting Countries, the statistical report, various years.

2.4.2 The development of production of oil and natural gas

Oil, since the start of exports in 1961 to the present time has been the main pillar of the economy and the most important source of national income in Libya. At the start, when the first oil was extracted the daily production figure was 17.500 barrels (Al Montaser and Garg, 1981).By 1968 this figure had risen to over three million barrels per day (Al Montaser and Garg, 1981). Libya controlled the production of crude oil, and consequently its oil wealth, for economic, political and most importantly strategic reasons. They tried to keep production at a level commensurate with the requirements of the national economy to earn sufficient resources to finance the regular and development expenditure of the country (al-Amin, 1979). This led to a reduction in crude oil output and a limit of two million barrels per day (al-Amin, 1979), and further reductions down to 1.486 million barrels in 2010 (Central Bank of Libya, 2009).

Natural gas is the second major source of energy after oil in Libya, and despite natural gas being a by-product of the oil production process, this was simply burned off, "flared" at the well head. Concern at this waste did not emerge until the beginning of the 1970's, when a number of measures were adopted to make efficient use of this surplus gas. This led to a reduction in the waste from 80 per cent in 1970 to 20 per cent in 1979 (Shah, 1996). As oil production fell during the period 1979-1986, the associated gas production also fell accordingly. From 1986 total gas production started to increase as they started to produce gas independently of the oil production; as a consequence the proportion of "non-associated" gas rose from 16 per cent in 1986 to 26 per cent in 1995 (Shah, 1996). Table 2.3 shows the evolution of the production of crude oil and natural gas during the period 1980-2010.

Table 2.3: Development of production of crude oil and natural gas during the period (1980-2010)

Year	Daily production rate of oil (Million barrels)	Total production of oil (Million barrels)	The total production of gas (Billion cubic feet)
1980	1.810	668.1	665.1
1981	1.218	429.8	448.4
1982	1.136	414.6	431.0
1983	1.030	375.9	441.4
1984	0.957	349.7	436.1
1985	1.001	365.4	450.5
1986	1.244	454.1	371.5
1987	0.973	355.0	395.1
1988	1.003	367.0	306.7
1989	1.129	412.4	354.4
1990	1.387	494.7	567.0
1991	1.649	601.9	593.6
1992	1.545	565.3	607.8
1993	1.389	518.4	506.3
1994	1.390	508.8	575.8
1995	1.399	510.6	591.7
1996	1.502	549.9	588.6
1997	1.395	509.2	558.0
1998	1.509	550.9	441.0
1999	1.445	527.7	482.5
2000	1.420	519.8	490.2
2001	1.416	516.8	486.2
2002	1.297	473.5	464.3
2003	1.431	560.0	493.4
2004	1.580	591.3	527.1
2005	1.693	618.0	765.4
2006	1.751	642.8	948.1
2007	1.673	653.8	1024.4
2008	1.721	643.6	1051.9
2009	1.473	592.5	1035.5
2010	1.486	616.0	1078.8

Source:

1. Organisation of Arab Petroleum Exporting Countries. the statistical report. various years.
2. Central Bank of Libya. Economic Bulletin. various issues.

2.5 THE DEVELOPMENT OF ELECTRIC POWER IN LIBYA

The electrical system in Libya is run by the general electric company of Libya (GECOL), owned by the state. The company was established under Law No. 17 of the year 1984 at the headquarters in Tripoli (General Electric Company, Annual Report), to undertake the implementation of projects in the operation and maintenance of electrical networks, energy production plants, distribution stations and conversion, power transmission lines and distribution, electrical control centres, management operation and maintenance of water desalination plants. The electric power system consists of the following main parts (Chlebek, 1993).

- Power plants;
- Transport networks; and
- Distribution networks.

2.5.1 Power plants

These stations generate electricity by generators drive turbines to produce electricity, and they rely on the primary energy sources such as coal, oil, natural gas, nuclear fuel, or exploit watersheds in electric power generation (Chlebek, 1993). It is worth noting that in Libya fuels are confined to oil and natural gas. These stations convert part of the energy in these sources into electrical energy; there are several types of plants differentiated by the power source used where, and by technical works station to generate electricity and limited types of power plants in Libya in three types (Guenos *et al.*, 1999). It is evident from table 2.4 that installed generation capacity has increased from (207) MW in 1970 to (8347) MW in 2010, an increase of (8140) MW, and this means that the installed generation capacity has increased by more than (40) times in three decades.

Table 2.4: The evolution of installed generation capacity megawatt during the period (1970-2010)

Year	**Steam**	**Gas**	**Diesel**	**Combined Cycle**	**Total**
1970	60	85	62	-	207
1975	250	418	142	-	810
1980	950	368	142	-	1460
1985	1705	605	125	-	2435
1990	2212	755	125	-	3962
1995	1972	2505	125	-	4602
2000	1972	2665	79	-	4716
2005	1812	3313	-	-	1525
2010	1240	4170	-	2973	8347

Source: General Electric Company, Annual Report, various years, unpublished

Besides the evolution of generation capacity vehicle, the power plants has improved in the quality of these stations that have become dependent on large sizes and relatively integration between the various means of production of steam and gas, as well as been achieved thermal efficiency better in some plants such as Al Khums steam station and Misrata iron station (Omran, 1993). Table 2.5 shows the installed generation capacity of all power plants in Libya during the year 2010.

Table 2.5: Installed generation capacity of all power plants in Libya during the year 2002

Type and the name of the station	Type of fuel used	Number of turbines	Turbine capacity (MW)	The ability of the station (MW)	Operating Year
1.Steam stations		20	519.5	1747	
Al Khums	Heavy / gas	4	120	480	1982
West of Tripoli	Heavy Heavy	5 2	65 120	260 240	1976 1980
Derna	Heavy	2	65	130	1985
Tobruk	Heavy	2	65	130	1985
Misrata iron	Heavy / gas	6	84.5	507	1990
2. Gas stations		36	1963	4245	
Ibokmash	Light	3	15	45	1982
Al Khums	Light / Gas	4	150	600	1995
South Tripoli	Light	5	100	500	1994
Zueitina	Light / Gas Light / Gas	4 2	50 285	200 570	1994 2010
Kufra	Light	3	25	50	1982
Al jabal algarpy	Light / Gas Light / Gas Light / Gas	2 2 1	156 156 156	312 312 156	2005 2006 2010
North Benghazi	Light / Gas	2	285	570	2009
Misrata	Light / Gas	2	285	570	2010
Alsaryer	Light / Gas	1	285	285	2010
Alsaryer AlNahr	Light / Gas	6	15	75	1990
3. Combined Cycle stations		15	945	2355	
Zawiya	Light	4 2 3	165 165 150	660 330 450	2000 2005 2007
North Benghazi	Light / Gas	3 1 2	150 165 150	450 165 300	1995 2002 2007
Total		71	3428	8347	

Source: General Electric Company, Annual Report, 2010

As for carrying electricity, there are two types of load for electricity:

- Essential load: the lowest required amount of electricity, which cannot be less than the demand at any time.
- Peak load: the maximum amount of electricity required at a particular time of the year.

The load electricity is measured in kW and electric power in kW / h, where that equivalent Megawatt million kilowatts, equivalent Giga watt billion kilowatts, the electric power is produced by the generator turbocharger, while the load electricity is an ability to produce this energy (Chlebek, 1993).

There was evolution of the growth of the maximum load and evolved electric power produced by power plants in Libya during the period (1970-2010), where growth of the maximum load of electric power increased more than (38) times. It rose from (151) MW in 1970 to reach (5759) MW in 2010, and increased growth of electricity produced from (653) GW / h (Giga watt /hour) in 1970 to (32558) in 2010, indicating that energy produced increased by 49.8 times in forty years. Table 2.6 shows the evolution of maximum load and electrical energy produced during the period (1970-2010).

Table 2.6: Evolution of the maximum load and the evolution of the electricity produced during the period (1970-2010)

Year	Peak electric load (Megawatt)	the produced electricity (Gigawatt/hour)
1970	151	653
1975	377	1812
1980	795	4577
1985	1243	7522
1990	1595	9851
1995	1976	11857
2000	2630	14296
2005	3857	22450
2010	5759	32558

Source: General Electric Company, Annual Report, various years, unpublished

2.5.2 Transport networks

It is worth noting that the electric power voltage (220) (kilovolt) KV is not suitable for industrial use or domestic. There are plants to reduce voltage at various points and appropriate transmission lines. These stations stretch medium voltage lines (66 or 30 kV) by iron Towers reaching a height of about 26 meters, or by underground cables inside the cities. The medium voltage lines can be fed to large factories demanding high usage such as iron and steel plants, petrochemical and others (Chlebek, 1993).

The transfer stations in Libya amounted to (749) stations in 2010, an increase of 331 compared with 1990 figure. The lengths of aerial transmission lines increased from (26554) kilometre (k. M) in 1990 to (39160) (k. M) in 2010, while the cables underground increased from (828) (k. M) in 1990 to (3034) (k. M) in 2010 (General Electric Company, Annual Report).

2.5.3 Distribution networks

Distribution networks extends from stations reduction voltage (11 kV), where electrical lines are connected to distribution networks through overhead lines on wooden poles or concrete poles in most regions. ,. The voltage (11 kV) is reduced through adapters reduce distribution hung on wooden poles or inside rooms private and graduated from these adapters electrical wires various efforts (380) volts maximum and (220) volts and (110) volts minimum, thus connecting power electricity to small consumers as houses residential, office and service institutions through distribution networks (Chlebek, 1993).

The number of stations in distribution networks that reduce the voltage reached (6915) station in 1999. Increased to (12800) in 2010, an increase of (5885) station, and the ground transformers increased its amount (5817) adapter in twelve years up to (14180) adapter in 2010, and increased by aerobic transformers (18999) adapter for up to (47432) adapter in 2010 (General Electric Company, Annual Report).

2.6 ELECTRICAL PROJECTS IN LIBYA

As previously pointed out, the electrical system in Libya is run by the General Electric Company of Libya (GECOL), owned by the state, which is responsible for generation transmission and distribution of electricity, throughout the country. In addition, the state-owned company is responsible for desalination of water plants in Libya. However, due to the projected high increase in demand for electricity throughout Libya, the government is undertaking several initiatives aimed at increasing the supply of electricity to the national grid. Elabbar (2008) revealed that the transitional government of Libya is on course to ensure that radical restructuring of the Electricity Ministry and GECOL is done, and projects, which had been initiated by the former president Muammar Gaddafi's regime, are revived to enable the country to meet the ever increasing demand for electricity.

Energy Market Report (2012) also indicates that what Award Ibrahim, the current minister for electricity and renewable energy is not certain about is whether his term in office could be renewed or not once a new government takes office. Nevertheless, the staff composed of professionals with a long history in GECOL expects radical sector reforms to be implemented immediately after the General National Congress 200-member team is sworn in. What is certain now is that work has begun to expand and refurbish national generation capacity and transmission infrastructure destroyed by forces loyal to former president Muammar Gaddafi during the conflict that took place from February-August 2011 preceded by an uprising against his regime (Energy Market Report, 2012).

In addition, several electrification projects are underway to either put up new projects or renovate and improve the electricity distribution networks to meet the rising demand for power. One such was witnessed when GECOL awarded Siemens a contract for the supply of 220 kv and 33/11 kv substations. It is also reported that three 400 kv substations together with the 250 MW gas turbines delivered to Zwitina Misrata and Bengazi power plants have already been successfully commissioned. GECOL reveals that this will add more than 1,500 MW of power to the country's national grid. In addition, another five 400 kv substations were to be constructed and commissioned by

2012. In total, GECOL projected its expansion program would help add more than 6300 MW during the period 2006-2012 (Ramelli, 2006).

Table 2.7: Generation power projects scheduled during the period (2004-2010)

Name of power plant	Installed Capacity (MW)	Expected execution period	Project present situation
W. Mountain P. Plant	660	2005-2007	Commercial Operation
Tripoli W. Extension I	650	2004-2006	Contract Awarded
Benghazi N.C.C.P	750	2005-2007	Commercial Operation
Gulf sytem P. Plant	1400	2004-2007	Under Contracting
Zawia C.C.P. Plant	1400	205-2007	Commercial Operation
Musrata Steel P. Plant	750	2007-2012	Under Study
Tripoli W. Extension II	650	2008-2012	Planned

Source: Ramelli 2006

The government of Libya having signed the Kyoto Protocol of 2005 is also engaged in the development of environmentally friendly sources of energy. One such is the solar energy. This is supported by the fact that Libya is a very hot country with more than 88 per cent of its land surface considered desert. This makes it a better country to use solar energy to help match the ever increasing demand for electricity. As a result, the government of Libya is encouraging its citizens to buy the solar panels sold by the government at subsidised prices. This project has helped inject more than 140,000 TWh/y (Terawatt hour/year) and has seen many rural areas that are not supplied with the national power grid due to population and need concerns, receive this green source of energy (Ekhlat *et al.*, 2007).

Research carried out in the country shows that Libya has immense potential for producing wind energy. This is in line with the government's orientation toward green energy. The government has identified several sites in the country with high potential of tapping wind energy to help meet the ever increasing demand for electricity in the country. The areas having been acknowledged include Misratah, Dernah, Sirt, Tolmetha, and Al Maqrun (Ekhlat *et al.*, 2007). These areas have the potential since they receive an average wind speed at a height of 40 metre above sea level. The Libyan government through GECOL expects that once the projects are completed by the year 2012, this will help add 15 TWh/y to the national grid, which is hugely significant as far as electricity is concerned. GECOL reports that this will see Libya become power self-sufficient by the year 2015 (Ekhlat *et al.*, 2007).

2.7 COMPARISON OF THE CURRENT PRACTICE IN UK ENERGY SECTOR AND LIBYAN ENERGY SECTOR

2.7.1 The current practice in the UK energy sector

The energy producing organisations in UK enforce measures that imply on a speculative of the process of energy production, with the aim of ensuring ethical reactor projects; however, the affiliated member organisations become the first to abide by the set regulations. The findings depict UK as a nation with a profound basis in economic growth and energy production (Daft and Marcic, 2013). Economists derive that the UK power production suffers fewer obstacles and further seeks to establish an environment where all citizens are secure from any isotopic emissions since they ensure that they hold a stake in the development through reviews and technical assistance. The need to address nuclear energy in the UK as a form of power is inevitable, this is due to its increased use to supplement other forms of energy (Singh, 2010).

With this understanding, and in reference to the above summary, the UK energy production and consumption practices entail information presented by four different studies on the production and use of the nuclear energy throughout the country. Energy production in UK's established on the approach that the different organisations are targeted to control the production of energy in the form of nuclear, and in accordance with the pact set by the global nuclear organisation. These practices stipulate the way in which the country's organisations are capable of guaranteeing health implications to the society (Daft and Marcic, 2013). The energy production enrolment among the organisations reflect an increased rate of 36.37 percent and 35.07 percent to total at 35.34 per cent aggregate based on the aggregate demands for energy in the country. The availability of nuclear waste in the UK was a propellant to the energy production as the country focused on eradicating the use of fossil fuels that caused adverse environmental effects and pollution (World Bank, 2012).

The indifferences in the energy sector and those lacking profound energy alternatives presents the rates of increased supply and the prospective investment rates. The utilities of producing energy also set for the sale of shares and stocks to the public to ensure that the entire UK society benefits from the yielded profits (Fisher, *et al.*, 2008). Under the constitution's provision of the energy regulatory acts, the under performing organisations, which account to a minute segment of energy production in the nation, are funded to deliver the anticipated amount of energy (Daft and Marcic, 2013). The problems that may arise from the threat of inappropriate energy production practices remain minimal since the government sets a platform to monitor the core practices. This persists in the production of energy and the use of approaches that are sound for avoiding poisonous emissions in the environment (Huusko, 2007). The commission has set methods to ensure that the country's carbon dioxide emissions reduce at a rate of 60 per cent by the year 2050.

The United Kingdom energy sector is divided into three distinct sections, suppliers, distributors, and generators. Suppliers consist of the companies who sell and supply gas and electricity. Distributors entail companies responsible for delivering energy to the consumers. They are responsible for the cables or pipes and meters, on the roads and within the consumer's property. Generators are the companies responsible for producing energy used by the consumers in their businesses and homes. In the past, coal was used to generate electricity, but more friendly ways of generating energy have been adopted (Energylinx, 2012).

Britain's electricity system has changed "from a state-owned system of regional monopolies to one of the most liberalised in the world, with a well-established regulatory framework" (HM Treasury, 2010, p11). Independent and strong economic regulation plays an important role in the framework. This is because it provides protection for consumers and stability for the investors. The Government in collaboration with the regulators are responsible for the protection of current and future consumers' interests, encouraging effective competition, and regulating monopolies in distribution and transmission. The electricity market in the United Kingdom is divided into:

- Distribution and transmission network at regional and national levels;
- Retail market where the suppliers bill and sell to consumers; and
- The wholesale market where the suppliers, generators and huge consumers purchase and sell electricity (HM Treasury, 2010).

In these markets, the energy firms are responsible for ensuring production capacity is present to meet the demand. They are also liable for investing in infrastructure. The company investment is supported by network monopolies that ensure that the networks are designed in a timely manner and that they support dependable transmission and distribution. At liberalisation, several companies moved into both the supply and generation markets. Following the liberalisation, both markets have become very concentrated. Six major energy companies dominate the retail electricity market; the companies have a 99 per cent share of the domestic supply (HM Treasury, 2010).

The six major energy firms are also vertically integrated (that is, they operate both in the retail and wholesale markets) and both produce power and sell it to the consumers. These companies are the major suppliers (supplying 67 per cent of electricity) in the wholesale market (HM Treasury, 2010). In the Europe region, the United Kingdom electricity supplies are the most reliable. Power outages are because of physical interruption to the distribution and transmission systems and not due to shortage of electricity production. Most of the UK electricity is generated in gas-fired power stations (HM Treasury, 2010).

The UK energy sector has developed a strategy to increase its use of heat, transport, and renewable electricity. The sector expects to generate 30 per cent of its electricity from renewables from the current 5.5 per cent. It expects to generate electricity from wind power, biomass, wave, tidal, hydro, and on and offshore. The sector anticipates generating 12 per cent of its heat from renewables and 10 per cent of its transport energy from the renewables. The energy sector has put into place mechanisms to offer financial support for the renewable heat and electricity worth approximately £30 billion between 2009 and 2020 (HM Government, 2009). It also plans to promote delivery and remove barriers, increase investments in emergent technologies, and seek new sources of supply, and create new opportunities for communities, businesses, and individuals to harness renewable energy.

2.7.2 The current practice in the Libyan energy sector

Libya's dependence on the use of energy sourced from non-renewable energy sources leads to increased leakage of carbon dioxide emissions. If the process of the lack of ethical energy practices reflects continuity, then it hinders national development in the energy sector of Libya. Furthermore, these practices are injurious to human welfare as the emissions pose threats to the Libyan population. Studies indicate the continued use of oil and natural gas in Libya as influential factors leading to the future uncertainties in the overall rate of environmental pollution (Gido and Clements, 2012). Anxieties arose after former president Muammar Gaddafi started to use the nuclear reactors set in Tajura for the production of weapons. This coincided with the period of armament, commonly referred to as the cold war period (Daft and Marcic, 2013).

Different countries steered the projects towards nuclear production with the new technology promising to affect the success of confrontation against aggressive and political enemies. The technology raises concerns further on the issue of environmental pollution with different approaches from different countries each forcing distinctive approaches to the disposal of the radioactive waste (Fisher *et al.*, 2008).

The value held in Libya's energy production sector is that the process of energy production is realistic about the individual citizens' demands through the endeared projects to provide an abundant supply of energy to the population (Gibney, 2005). Tests of competence reflect on the country's energy performance and capabilities as still below the required global rate since it was until the end of 2011 that Libya was upholding to the use of renewable energy sources in the domestic sector (Devlin, 2010). Some of the country's economists argue that the country should shift from the use of non-renewable energy and use it for the creation of revenues while embarking on the use of renewable energy for the domestic sector of the economy.

The influence of the Libyan society in the production and the use of energy extend to other world affairs and remains intense, based on the fact that the society approaches of energy are indirect to the production of other secret elements. Although Libya showed in the Tajura nuclear project, the main reason behind the involvement did not reflect saving the production and consumption of energy in the country. The country continually engaged in the production of weapons (World Bank, 2012). Therefore, the energy production practices in Libya seem to differ from those of the UK in many ways.

Trends in energy production, use and consumption may be subject to change over time as happens with other commodities. The current energy sources in most nations cannot be regarded as sustainable. This is because of increasing energy costs, environmental issues, and the limitation of sources. In Libya, the conventional energy sources are limited to two, oil and natural gas. Estimated resources for oil amount to 40 billion bbl (barrel) while for natural gas it is estimated to 1,300 billion m^3 (Saleh, 2006). The electric energy industry development in the last decade has become the social and economic development of Libya. The peak load increased from 1595 MW in the year 1990 to approximately 3857 MW in 2005. The total installed capacity increased from 3352 MW in the year 1990 to about 5120 MW in 2005 (Ekhlat *et al*., 2007).

The generated electric energy increased from 9851 GWh in the year 1990 to about 16000 GWh in 2005. Steam power plants contribute 65 per cent of electricity, natural gas contributes 32 per cent, heavy oil fuel 33 per cent and light oil contributes 35 per cent (Ekhlat *et al*., 2007). The energy consumed per capita has risen from 1493 KWh/c in 1990 to about 3119 KWh/c in 2005. Ninety-nine per cent of the population in Libya can access the national electricity network. Majority of the electricity network is found on the coast and this is where most of Libya’s inhabitants live (Ekhlat *et al*., 2007). It is expected that the electric energy demand will grow very rapidly, for instance, by 2014, it is expected that the electrical energy demand will double (Ekhlat *et al*., 2007).

The number of consumers in Libya’s electricity system is approximately one million. Thirty-nine per cent of the total consumption is represented by the residential sector.

Thus, the residential sector accounts for the highest share of electrical energy demand in the nation (Ekhlat *et al.*, 2007).

As stated before, Libya's energy sector plays a critical role in accomplishing economic and social development by satisfying the energy requirements of the various economic sectors. Although it plays a vital role, the sector has a number of features that can influence its contribution to the attainment of sustainable development. This is because of changing consumption patterns and unsustainable energy production especially in the end use sectors. The industry has had its adverse environmental effects on soil, water, and air resources. Libya has been experiencing strong economic growth in the past few years, which has made it one of the most successful nations in Africa based on its GDP (Ekhlat, 2007).

The utilisation of renewable energies has been presented in various applications because of being economically effective and convenient in most applications. Libya uses various renewable energy resources such as solar energy photovoltaic conversion, wind energy, biomass, and solar thermal applications (Saleh, 2006). The following Table shows the potentiality of renewable energy sources to generate electricity in Libya.

Table 2.8: Renewable energy sources for Libya

Type	Potentiality
Solar electricity	140,000 TWh/ y
Wind electricity	15 TWh/ y
Biomass	2 TWh/ y
Total	157,000 TWh/ y

Source: Saleh 2006

The utilisation of photovoltaic (PV) systems began in 1976 and from that time, many projects have incorporated these for various applications and different sizes and the use of the PV systems for illumination and rural electrification began in 2003. PV systems have found a growing number of application types, and their function has grown significantly (Saleh, 2006).

The problem facing the electrification of areas far from the existing electricity network and areas with low population is a financial one. It is very expensive to expand the high voltage lines through the desert to electrify a few hundred dwellings. In most of the low population nations, electricity is available in the cities and an electricity network lacks the supply of power to these rural homes. Libya plans to electrify the rural areas, which entails electrifying water pumping, villages, and scattered houses. A project was initiated to supply electricity to remote areas using the PV systems (Saleh, 2006).

Ten villages were used for the project and some of the villages include Mrair Gabis village (representing scattered houses), Swaihat village (scattered houses), Intlat village (scattered houses), Beer al-Merhan village (scattered houses), and Wadi Marsit (representing a village with a diesel generator). As stated earlier, photovoltaic systems installation began in mid-2003. Several companies have installed the PV systems and they include GEOCL, which installed 340 PV systems with a capacity of 220 KWp (Saleh, 2006). The Saharan Center and the Centre of Solar Energy Studies installed 150 PV systems with a capacity of 125 KWp (Saleh 2006). Three hundred and eighty PV systems were used for isolated homes, 30 for police stations, and 100 for street illumination. The peak power produced by all the PV systems in Libya totals 345 KWp (Saleh 2006). Water pumping is regarded as one of the common applications of PV systems in Libya for the remote wells that are utilised to supply animals and people with water. The project (water pumping) entails installation of 40 PV systems with a power capacity of 120 kW (Komoto, 2009).

2.7.3 Comparison of the two energy sectors

There are significant differences and similarities between the current practices of the Libyan energy sector and the United Kingdom sector. The United Kingdom energy sector is clearly divided into three sections, that is, suppliers, distributors, and generators. For the Libyan energy sector, there are no clearl distinctions. This can be attributed to the fact that the company that manages the Libyan electrical system is state-owned. In the UK, the situation is different because the companies responsible for the generation of electricity are not state-owned. In fact, the number of the main companies supplying and generating electricity are six. This situation has created a competitive environment, which has ensured that consumers' demands are fulfilled (Freudenburg and Gramling, 2011).

In Libya, GEOCL (the state-owned company) struggles to meet the demands of the consumers although it claims that it has reached 99 per cent of the population. The inability to meet the demand is because of where the consumers live. Some of the consumers live far from the main electricity generating plants. Those who can access electricity without problems are those living in the cities. This has forced the company to install PV systems to these areas for purposes such as water pumping, electrification, and illumination.

As stated before, the competitive nature of the UK electricity generating and supplying companies has made it possible for them to meet the demands of the consumers. However, with the growing demand for electricity, both energy sectors (UK and Libyan) have been forced to look for other alternatives to generate electricity. The most common method used by both energy sectors is the use of renewable resources. The prevalent renewable source of electricity in Libya is the solar energy using the PV systems. Though there are prospects for using wind power and biomass as renewable sources, they have not been fully developed like the PV systems. However, the PV systems are still being tested and have been initiated as projects in some of the villages and scattered houses in Libya. According to Komoto (2009) the systems have proved useful and very efficient.

In the United Kingdom, the renewable energy sources in use include wind power, biomass, wave, tidal, hydro, both on and offshore. The sector plans to increase the generation of electricity by 30 per cent from these sources. A remarkable feature about the two energy sectors is the use of gas-fired generated electricity. Most of their electricity is generated from gas-fired power plants. Thus, both energy sectors rely heavily on electricity generated from natural gas. Just like the United Kingdom, Libya is planning to generate more electricity from renewable sources (Ekhlat *et al*., 2007). However, it is not clear if they are planning to use technology in harnessing the renewable resources like the United Kingdom.

The current plan for Libya is to electrify the rural areas using a number of renewable energy sources, which are still in the project phase. Ekhlat *et al*. (2007) state that the other renewable sources of energy apart from solar energy have lower potential in Libya. However, the government has plans to make full use of the less potential renewable resources by the year 2020 (Ekhlat *et al*., 2007). The use of renewable energy sources by both energy sectors is to ensure that carbon emissions are reduced and to meet the increasing demand from consumers.

2.8 DISCUSSION

El-Arroudi *et al.* (2009) noted that Libya is an oil-exporting country situated in North Africa, bordering the Mediterranean Sea, with an estimated 6 million inhabitants spread over an area of 1,750,000 square kilometres The country is very hot, experiencing a daily solar radiation of 7.1kWh/m^2 in the coastal areas and 8.1kWh/m^2/day in the south. The national electricity grid has a high-voltage network estimated at 12,000km, with an installed capacity of 5600 MW and a peak load of 3650 MW, according to Elabbar (2008). Despite these statistics, some areas are located far away from the national grid. This implies that these areas cannot be connected to the grid due to the fact they have small populations, and only a small amount of energy is needed. Libya mainly depends on oil and natural gas as its chief sources of energy (Elabbar, 2008). In fact, many European countries depend on its oil. Nevertheless, the country also depends very much on electricity for both industrial and domestic use. According to Ekhlat *et al.* (2007) Libya's electric energy sector has undergone incredible development during the last decade, as it is the key ingredient for social and economic development. The country's peak load increased between 1990 and 2005 from 1595 MW to 3875, while installed capacity also increased from 3352MW to 512MW during the same period. Generated electricity during this period also increased from 9815DWh to 22500GWh. Ekhlat *et al.* (2007) revealed that steam power plants contributed 65 per cent, while natural gas contributed 32 per cent, heavy oil 33 per cent and light oil 35 per cent of electric energy. Libya's energy consumption per capita also increased between 1990 and 2005 from 1493 kwh/c to 3119 kwh/c.

The Energy Market Report (2012) reveals that the national electricity grid is accessible to 99 per cent of the population. The report also showed that the greater part of the electricity network is concentrated in the coastal part of the country where the majority of its people live. The electricity demand is also expected to increase rapidly in the coming years. It is expected that the demand for electric energy could double by the year 2014 and could be more than three quarters by the year 2020 (Ekhlat *et al.*, 2007). Abdullah and Ekhlat (1998) asserted that Libya's total number of electricity consumers stands at about one million distributed among seven categories. The residential sector is the major consumer of electricity at 39 per cent followed by the commercial sector at 14 per cent. Libya's electricity system is run by the state-owned General Electricity Company of Libya (GECOL), which is responsible for generation, distribution and transmission of electricity throughout Libya. Below is a table 3.1 showing projected Libyan energy requirements for 2050 according to Ramelli (2006).

Table 2.9: Evolution scenario for Libya

Type	2005	2050
Population	6 million	10 million
Electric power generation	3500 kWh/cap/y	5000 kWh/cap/y
Electricity demand	20 TWh/y	50 TWh/y
Water	6 billion m^3/y	10 billion m^3/y

UK energy producing organisations establish that the programs should undergo evaluation prior to their implementation. Libya should adapt the approaches as a necessity to the diminishing levels of performance, hence denoting the vitality for a strategic resolution to ensure that its energy production confers with the global policies (Freudenburg and Gramling, 2011). The valuation approach that the country will resolve to use and establish the perceived global practices is inborn to the reduction of government influence in the production sector. The increased privatisation and decreased government influence through nationalisation is analytically established as the precise role of targeting to ascertain the occurrence and acquisition of the vital economic objectives (World Bank 2012).

Initially, the country had preserved a profitable market share ahead of other nations in the OPEC. However, the enlightening of the Libyan society into adopting environmentally friendly matters projects the dire need for the authorities to set a situation of diminishing usage of non-renewable energy as the society's reactions might daunt the overall economic performances. Arguably, the country should resolve to develop a plan that would steer the acquisition of the set recovery measures. Studies indicate on the continued use of oil and natural gas in Libya as influential factors leading to the future uncertainties in the overall rate of environmental pollution (Beatty and Scott, 2005). The solution held to the findings is that the government curbs the use of renewable energy sources for the process will hurt economic plights due to the differences in the demand for renewable energy.

Further, these changes will set to recuperate the ill situation in the country's production of energy through draining carbon dioxide emissions. Following the use injurious oil, the country should engage in increased production of renewable energy since it has enough capital to intensify investments in handling the disaster of oil usage in its economy (Devlin, 2010). Having lost the best reputation in its mining and processing to the marketing programs, Libya stands a chance to reverse the situation (World Bank 2012). Further, Libya should lessen its involvement in the domestic use of renewable energy as value by selling a lot of its oil in African nations.

The country should encourage the use and production of renewable energy. This shall derive the desired value of economic performance to an enhanced gross domestic product and incomes per head. Perceptions of the intense relevance of reduced taxation towards the levels of unemployment reflect towards either increased investments or more employees in the country's industries. In conclusion, the population growth in Libya set the need for increased energy production, and without massive production utilities in the country at the rate of 21.83 per cent with the domestic consumers depicting increased demand levels of 5.41 per cent and the industrial sector reflecting a 14.75 per cent demand (World Bank 2012).

2.9 CHAPTER SUMMARY

The purpose of this chapter was to review the energy sector in Libya and to shed light on the electric power in Libya in which this study is conducted. This chapter presented background on the social, economic and political characteristics of Libya. The concept of energy, sources of energy, role of energy sources in the Libyan economy, evolution of the reserves, the production of oil and natural gas have been discussed, emphasising the development of electric power in Libya. In addition, this chapter has taken a look to the current practice in the UK energy sector and has compared it to the Libyan energy sector. The following chapter will discuss the demand for electric power in the economic literature, highlighting the theme of key determinants affecting the demand for electricity, the main research approaches and the main findings of the previous research in the field.

CHAPTER THREE: DEMAND FOR ELECTRIC POWER IN THE ECONOMIC LITERATURE

3.0 INTRODUCTION

Electricity is a source of power that is used across the modern world. This power source is known for its cleanliness and reliability although it can be expensive depending on how it is produced. During the design and commissioning of an electricity-producing plant, one factor that has to be established is the demand function. The demand function is, however, affected by several factors. The establishment of the demand function is complex and needs thorough analysis. Some of the factors that impact on demand for electric power include population, government policy, and equipment's electricity ratings (Abosedra *et al.*, 2009).

Electricity demand is said to be a practical inference and analysis of the demand function. This has been a major issue for the last few years because of the complications associated with its estimation, large fluctuations and validity. Electricity is one of the most fundamental determinants of socio-economic development of modern society. It is no exaggeration to argue that electricity is an engine of growth at both local and global levels. Developing countries in particular are witnessing a rapid increase in demand for electricity, which has elevated the importance of research in the electricity sector. Similarly, the fact that electricity resources are very scarce also brings the need to scrutinise electricity demand policies. Alter and Syed (2011) noted that the *International Energy Agency* has predicted that underdeveloped countries globally will increase their electricity consumption from 20.5 per cent in 1999 to 35.8

per cent in 2020. This raises the need to address the issues regarding demand for electricity.

Abosedra *et al.* (2009) noted that the nature of electricity differs significantly from other commodities due to the fact that electricity is a non-storable commodity affected by significant diurnal and seasonal variations in demand. Forecasting and estimation of demand for electricity can assist in apt investment in new infrastructure and ensuring successful operations of all kinds of electrical utilities in order to be able to meet the customers' demands in a more cost-effective way. In addition, accurate forecast of demand is vital for better planning of generating utilities and monitoring system security.

Studying demand for electricity both for the purposes of consumption or production is different from the studying of the demand for other goods and services, the demand for electricity for domestic purposes such as lighting and heating is a final demand; where they (others goods and services) are the basic needs of the consumer, the demand for electricity for industrial, agricultural and commercial (for the production of a good or service) is derived demand.

Microeconomic theory suggests that the quantity demanded of any commodity depends primarily on the level of real income and the price of the commodity in question and other commodity prices associated with the commodity. Also the usual traditional model of the demand for electricity shows that the quantity of electricity demanded is associated with the level of real income and the price of electricity. However, many empirical studies took into account the fact that electricity as a commodity is different from other goods, and this suggests these studies add new variables in the demand function for electricity (Intriligator, 1978).

Accordingly, this chapter elucidates the most important characteristics of electric power as a commodity that makes it different from other commodities, also reviews the proposed variables to electricity demand functions in the economic literature, in addition to a brief overview of some of the applied studies in this area.

3.1 CHARACTERISTICS OF ELECTRIC POWER

Electrical power has characteristics that make it different from the rest of the goods and services consumed by individuals and producers, the most important of these characteristics are the following:

- Rising costs are necessary for establishment and operation of power plants from whatever source - water, thermal or nuclear energy or groundwater - which include the costs of generation, transmission and distribution (Seifi, 1986);

- Low efficiency of electric power generation leadsto the need for power plants and substations to carry out renovation and maintenance that may cause power outages (Mandour, 1988);

- There are differences in the cost of electricity from one voltage to another, because when transferring power across the transport networks and transfer stations and until it arrives to subscribers, there is added cost to the network for each stage from the previous stage and so on. Furthermore, the cost of the loss that occurs during the process of transmission and distribution of electricity where each unit of consumption of electricity is causing the loss of two units in the process of power generation and transfer process need to be taken into account (Ismail, 1988);

- Electricity cannot be stored in large quantities and therefore, the electricity needs to be generated at the moment of request at any hour of the day. This means that the electricity sector will supply more than one product because there is a difference in the supply of kilowatt / hour during the peak period and in the supply of the same kilowatt / hour in the period before and after the peak (Mandour, 1988); and

- There is the need for a reserve sufficient electric capacity in the range of 15 per cent – 20 per cent of the maximum required, in order to meet the unexpected increase in demand for electricity or forced exit of some generating units of service in addition to the units that come out of maintenance due to the establishment of plants in various types which needs to be a period of five to eight years (Mandour, 1988).

3.2 AN OVERVIEW OF PREVIOUS STUDIES ON THE DEMAND FOR ELECTRICITY

The first comprehensive study to examine electricity demand using an econometric model was conducted by Houthaker (1951). Following on from the Houthaker (1951) study, many other econometric studies have been developed for different countries. The most notable are Elton and Hajee (1999) AlZayer and Al-Ibrahim (1996), Al Sahlawi (1990), Micklewright (1989), Khan and Qayyum (2008), Tariq *et al*. (2009) Khan and Osma (2009) Silk and Joutz (1997) and Lin (2003) among others, according to Alter and Syed (2011). The literature on energy demand indicates that income and price elasticities have been used to gain a better understanding of the pattern of demand to enable other undertakings such as demand management, forecasting and policy analysis to proceed. Alter and Syed (2011) noted that price and income elasticities are more significant in designing policies for restructuring since price is a key component of reform.

According to Khan and Qayyum (2009), electricity prices, income, number of customers and temperature appear to be the greatest determinants of the electricity demand function. This function, they argue, can be estimated through integration and Error Correction Model (ECM). Their study concluded that variables are significant with their expected signs in both long- and short run electricity demand, which are both price and income elastic. In Pakistan, for instance, the determinants of demand include real income, prices of electricity, population, imported appliances, temperature and number of customers.

Price elastic electricity demand holds that electricity is a luxury commodity that is unique, but Khan and Qayuum (2009) substantiate their findings by asserting that the majority of areas in Pakistan are rural, and in most parts of these areas electricity is not yet connected. In their study, they argue that electricity acts as both income and price inelastic. During their study, they were able to observe that price- and income-inelastic demand show electricity to be a basic necessity due to the fact that, in the current world, no one can think of his/her life as being complete without electricity. This conclusion was arrived at after taking data from Pakistan and performing an estimation using cointegration and ECM through a Vector autoregression (VAR) framework. Nevertheless, these findings conflict with those of a study carried out in Pakistan by Jamil and Ahmad (2010), who explained the causality from electricity prices and real income to electricity consumption. After performing a thorough analysis, they found out that long run elasticity recognised the demand for electricity as income-elastic but price-inelastic with significant error. In addition, they revealed that, in the short run, the majority of sectors have both price- and income-inelastic electricity demand. This research provided a helpful result but mainly focused on the determination of causality linkage between income, electricity prices and electricity consumption.

Athukorala and Wilson (2010) investigated the short run dynamics and long run equilibrium relationship between residential electricity demand and factors influencing demand per capita income, price of electricity, price of kerosene oil and price of liquefied petroleum gas using annual data for Sri Lanka for the period, 1960–2007 using three models namely, unit root, cointegration and error-correction models. They found that the long run income elasticity of demand revealed that any future increase in household incomes was likely to significantly increase the demand for electricity and that any power generation plans should take into account the potential future income increases rather than current per capita consumption and population growth only in order to avoid power shortages. This shows that price elasticities are a good indicator of how the demand for electricity will be in future and planning to be made accordingly.

Zaman *et al.* (2012) recently investigated the multivariate electricity consumption function for Pakistan, particularly, economic growth, foreign direct investment (FDI) and population growth over the 1975-2010 time period. They used the bounds-testing procedure for cointegration to examine both the short run and long run estimates. They found that the determinants of electricity consumption function are cointegrated and influx of FDI, income and population growth was positively related to electricity consumption in Pakistan.

Saravanan, *et al.* (2012) examined the electricity consumption in India using various variables including: amount of carbon dioxide emission, population, per capita GDP, per capita gross national income, gross domestic savings, industry, consumer price index, wholesale price index, imports, exports and per capita power consumption. According to Saravanan *et al*. (2012), electricity demand increases due to population growth, higher per capita consumption, and rapid development of industrial and commercial sectors, higher Gross Domestic Product (GDP) growth and structural changes in the economy of India with other countries. This implies that GDP plays an important role in the modelling of the country's future electricity demands.

Previous studies have tried to link the impact of energy consumption to economic growth, in other words, there is evidence from past studies that energy consumption acts as a stimulus to economic growth. Others have argued that economic growth stimulates energy consumption (Jumbe, 2004). The relationship between energy consumption and economic growth has important policy implications. For example, if causality runs from energy consumption to economic growth then it means that an economy depends on energy and hence energy is an important stimulus of economic growth. This implies that shortage of energy is likely to have negative impact on economic growth. Poor economic performance arising from shortage of energy is also likely to lead to poor income and rising unemployment. According to Stern (2000), energy is a limiting factor of economic growth. The converse is true when the causality only runs from GDP to energy consumption in which case the economy of a country does not depend on energy (Masih and Masih, 1997). Consequently, policies in the energy sector may not impact the economic growth and employment significantly (Jumbe, 2004).

Dilaver and Hunt (2011) investigates the relationship between Turkish aggregate electricity consumption, GDP, average real electricity prices, and an Underlying Energy Demand Trend (UEDT) in order to produce forecast scenarios. This study estimated an aggregate electricity demand function for Turkey by applying the structural time series technique to annual data over the period 1960 to 2008. The results suggest that GDP, electricity prices and an underlying energy demand trend (UEDT) are all important drivers of Turkish electricity demand. The estimated income and price elasticities are found to be 0.17 and -0.11 respectively with the estimated UEDT found to be generally upward sloping (electricity using) but at a generally decreasing rate. Based on the estimated equation, and different forecast assumptions, it is predicted that Turkish aggregate electricity demand will be somewhere between 259 TWh and 368 TWh in 2020.

Issa and Bataineh (2010) studied demand for electricity in Jordan during the period (1979-2008), using Breusch-Godfrey Serial Correlation LM Test to check for serial correlation between variables, also it used Philips perron test to examine the stationarity of the variables, in addition it used least squares analysis to examine the relationships between variables, and finally it used the Ramsey RESET test to check for the stability of the model, an econometric model was built, and the total consumption of electricity was used as the dependent variable. The independent variables that are per capita real GDP, real price of electricity and the efficiency were examined for their impact on the demand for electricity.

The study found that the per capita real GDP variable had a significant positive effect on the demand for electricity. Alternatively, the real price of electricity and efficiency variables were found to have a significant negative effect on the consumption of electricity. The study suggests that the results may have implications for policy makers who should focus on macroeconomic factors such as GDP per capita, price of electricity and efficiency to be the main factors affecting the demand for electricity.

Khattak *et al.* (2010) used Multinomial Logistic Model for estimating the demand for electricity at households in the district of Peshawar. Primary data was collected for this purpose from 200 households of City Rural Division during November-December 2009. The study concluded that income, number of rooms, price of electricity, weather and education are important determinants of household demand for electricity in the district of Peshawar. However, the study suggested that a provincial level study in this regard will be more helpful for government in understanding the real pattern of domestic demand for electricity. Khattak *et al*. (2010) suggested that a provincial level study will be more beneficial to get clear estimates of residential demand for electricity. This study will be helpful for government in understanding the future trend and pattern of residential demand for electricity in Peshawar.

Abosedra *et al.,* (2009) estimated the demand for electricity using ordinary least square (OLS), autoregressive integrated moving average method (ARIMA) also known as the Box-Jenkins methodology, and exponential smoothing for January 1995 to December 2005. In the Abosedra *et al.* study, the ARIMA model, followed by exponential smoothing and OLS, was most accurate in tracking demand for electricity during the period. Based on their study, the authors recommended univariate time-series modelling for forecasting demand "until detailed data on various socio-economic variables becomes available" (Abosedra *et al*. 2009).

The said Abosedra *et al.* (2009) findings indicate that the authors are also dissatisfied with their ARIMA model. ARIMA modelling uses the lag, averaged, and differenced values of electricity demand for forecasting future demand (Gujarati, 1995; Abosedra *et al.,* 2009) and, thus, ARIMA models do not provide a good theoretical foundation for forecasting other than a claim that demand may be following a business cycle or seasonal fluctuations. Abosedra *et al*.'s exponential smoothing does not provide information as the demand for electricity was merely regressed using a time trend variable and variables to represent seasonal fluctuations. The exponential smoothing technique indicated only two things: 1- demand follows a linear time trend; and 2- demand fluctuates across seasons.

Unfortunately, the Abosedra *et al.* (2009) study gave a poor rating for the OLS technique. However, the Abosedra *et al.* (2009) OLS estimate on the demand function for Lebanon can be described as good given that their OLS regression for electricity demand for Lebanon has an adjusted R-square of 0.823038 implying that variations in the values of the regressors explain around 82 per cent of the variations in the regress and or dependent variable which is demand for electricity in Lebanon in this case. The Abosedra *et al.* (2009) regression of Lebanon's demand for electricity used real imports, relative humidity, and monthly temperature as regressors. Despite a better theoretical foundation for the regression, however, Abosedra *et al.* (2009) gave their OLS regression a poor rating. It is the position of this work that Abosedra *et al.*'s OLS have a better foundation in theory and that Abosedra *et al.* should have perfected the model instead of rating the OLS as the inferior regression relative to the ARIMA and exponential smoothing methodology

Neeland (2009) studied demand for electricity in the United States for 1970 to 2007 using the Augmented Dickey Fuller (ADF) unit root test, Johansen test, and a rolling regression. Although the Neeland study did not provide fit statistics of the regression, the author claimed nevertheless that his regression showed that the primary driver of adjustments in electricity consumption is its own price elasticity of demand and growth in real income per capita (Neeland, 2009). According to Neeland (2009, p. 202), the study *"determined that changes in electricity price and real income per capita, more than any other factor examined, influence energy consumption patterns of US residents"*. The other variables examined by Neeland included temperature change and the price of substitutes.

The ADF unit root test applied by Neeland used the change in prices as the dependent variable and the lagged and differenced values of price (Neeland, 2009). The Johansen test involved testing for the co-movement of variables (Neeland 2009). Finally, the rolling regression involved a "simple linear regression" in which the "earliest observation is dropped and the latest is added" (Neeland 2009). Unfortunately, data on fit and R-squared are not available on Neeland (2009) study that can allow researchers and policy makers to make a good assessment of Neeland regressions.

The work of Labandeira *et al.* (2009) estimated the demand for electricity in Spain using data from September 2005 to August 2007 using observations from 422,696 households, 30,499 companies and 688 large consumers. Labandeira *et al.* (2009) used a demand function for companies and households. For the households, the independent variables covered climatic factors, and household characteristics. Dummies for time and location were also included to explore possible location and temporal effects on electricity consumption. There were missing data and Labandeira *et al.* (2009) handled the situation by executing transformation techniques. For household demand for electricity, a log linear model of the variables was employed, thereby making possible the computation of elasticity values. Labandeira *et al.* (2009) implicitly expressed that in the future, a possible improvement in the model can factor in the role of decision to consume goods linked to the use of energy product.

Unfortunately, the Labandeira *et al.* (2009) regressions did not report statistics that would enable are to assess the validity of their regressions. Report on the adjusted R square and validity of fit data are not available on their regressions. Furthermore, statistics on possible serial correlation were not reported by Labandeira *et al.* (2009). Nevertheless, Labandeira *et al*. (2009) concluded from their regressions that electricity demand is inelastic to price in the period assessed. Labandeira (2009) also reported that income and activity are important factors in explaining the demand for electricity among households. In a concern that this proposed study seeks to address, the

Labanderia *et al.* (2009) regressions also found that temperature changes have a small but highly significant effect on consumer demand.

For Brazil, Carlos and Notini (2009) applied a time varying parameter error correction model to estimate the country's demand for electricity during the period 1997 to 2007. However, despite their sophisticated modelling, the adjusted R-squares of their two regressions are poor values 0.352707 and 0.059238. This is very different from the value obtained by Abosedra *et al.*'s OLS adjusted R-square of 0.823038. On this basis, the Carlos and Nossini (2009) regressions are inferior compared to the Abosedra *et al.* (2009) regression that included an OLS regression.

For Mexico, Chang and Chombo (2009) used co-integration and error-correction models with time varying parameters for estimating the demand for electricity, using monthly Mexican electricity data for residential, commercial and industrial sectors. Income, prices and a nonparametric temperature measure are used as explanatory variables, and the income elasticity is allowed to evolve slowly over time by employing the time varying coefficient (TVC) co-integrating model. The specification of the proposed TVC co-integrating model is justified by testing it against the spurious regression and the usual coefficient (FC) co-integrating regression.

The estimated coefficients suggest that the income elasticity has followed a predominantly increasing path for all sectors during the entire sample period, and that electricity prices do not significantly affect in the long run the residential and commercial demand for electricity in Mexico. Despite their sophisticated models, their best regression has a value of 0.829. Although one of the Chang and Chombo (2009) regressions has an adjusted R squared value of 0.975, the regression has Durbin Watson statistics of 1.47 indicating serial correlation and low regression credibility.

Louw *et al.* (2008) studied electricity demand for newly electrified low-income African households, the study follows two typical low-income rural sites in South Africa, Antioch and Garagapola and it was found that income, wood fuel usage, iron ownership and credit obtained were significant in determining consumption levels within these households. Price and cross-price elasticities were difficult to assess due to lack of data within the sample. The results have many possible implications for policy, including the effect that easily obtained credit has for low-income households.

Earlier for Spain, Villadongos (2006) used an ordered probit with instrumental variables of contracted power by consumers and found that electricity power contracted by each household depends on electricity consumption and household characteristics. The household characteristics include ownership of central heating, location of community, rural/urban characteristics, year of construction of the dwelling unit, size of dwelling unit, gas supply, and type of house ownership (Villadongos, 2006). The maximum likelihood R squared of the Villadongos (2006) regression, however, is low at 0.334.

Meanwhile, a study done a year earlier than Villadongos (2006) used OLS techniques for estimating demand for electricity based on the 1973 to 1995 data and found that home ownership is a relevant factor that explains spending for energy in Spanish households (Labandeira e*t al.*, 2006). Based on the regressions, Labandeira *et al.* (2006) also found that demand for electricity is negatively related to the educational level of the head of the household, positively related to income, qualitatively related to age, and qualitatively related to place of residence. Labendeira *et al.* (2006) articulated that their work is a significant contribution to literature in that their regression demonstrated the role of household characteristics in the demand for electricity.

Unfortunately, however, while t-ratios for the Labandeira *et al.* (2006) regressions are available, the F, adjusted R-squared, and Durbin Watson statistics are not. Labandeira *et al.* (2006) wrote about the residential energy demand system for Spain. Their study was motivated by the sharp price fluctuations and increasing environmental and distributional concerns, among other issues in Spain. Using household micro data, they estimated Spain's energy demand system. They combined data sources for a long time period and chose a demand system with flexible income and price responses including varying responses to energy price changes by households living in rural, intermediate and urban areas. This comprehensive model revealed that the electricity demand was both price and income elastic.

Narayan and Smyth (2005) estimated long- and short run elasticities of residential demand for electricity in Australia using the bounds testing procedure to co-integration, within an autoregressive distributive lag framework. They found that income and own price are the most important determinants of residential electricity demand, while temperature is significant some of the time and gas prices are insignificant in the long run. They reported that the short run elasticities are much smaller than the long run elasticities. In addition, they concluded that population is an important determinant of electricity demand in Australia.

Holtedahl and Joutz (2004) examined the residential demand for electricity in Taiwan as a function of household disposable income, population growth, the price of electricity and the degree of urbanisation. They found that the income elasticity is unit elastic in the long run while the income and price effects are smaller in the short run than in the long run. Temperature effects have a positive impact on short run consumption. They also reported significant influence of population growth on the residential demand for electricity in Taiwan.

Guertin *et al.* (2003) highlighted the role of appliances, temperature, and house characteristics in influencing demand for electricity in Canada. For the United Kingdom, Patrick and Wolack (2001) developed a framework for estimating demand for electricity in the United Kingdom and found that demand for electricity can vary within a day. Patrick and Wolack argued that their findings could be used by firms to develop price bid policies that are variable even within a day (Patrick and Wolack, 2001). In summary, Patrick and Wolack (2001) argued that their paper has formulated a general framework for estimating the within-day customer demand for electricity.

Ghosh (2002) examined the cointegration and Granger Causality for India using data between 1950 and 1997. The study failed to establish a co-integrating relationship, but found short run Granger Causality flowing from economic growth to electricity consumption without a feedback effect. Jumbe (2004) applied the Granger-causality and error correction techniques on 1970–1999 data for Malawi in an examination of cointegration and causality between electricity consumption and GDP. The Granger causality results detect bi-directional causality between electricity consumption and GDP suggesting that electricity consumption and GDP are jointly determined. Chen *et* *al.* (2007) provides extensive summary tables of results for Granger Causality between economic growth and electricity consumption for a number of countries.

Chontanawat *et al.* (2006) provided further evidence that GDP is an important determinant of electricity demand. They tested causality between energy and GDP using a consistent data set and methodology for thirty OECD and seventy-eight non-OECD countries (Chontanawat *et al.,* 2006). As expected, they found that aggregate energy consumption to GDP was more prevalent in the developed OECD countries than in the developing non-OECD countries. This implies that any reduction in energy consumption is likely to have greater impact on the GDP of a country and vice versa.

Halvorsen and Larsen (2001) used the annual Norwegian Survey of Consumer Expenditure for the period 1975 to 1994 to estimate the short and long run own price elasticities. The empirical estimates of long run effects on residential electricity demand from changes in the electricity price were estimated by cross-sectional variation in the current stock of electric household appliances across households at a certain point in time. They found that the estimated long run elasticity was only marginally more price elastic than in the short run. They argued that there are no substitutes for electricity used in electrical appliances.

3.3 DETERMINANTS OF DEMAND FOR ELECTRICITY

3.3.1 The role of income on demand for electricity

Income is one factor that affects the standard of living in a place. Real income of an individual is one of the major determinants of demand for electricity. This is because real income determines an individual's purchasing power, which in turn determines the appliances that the person may acquire that demand electricity. In this regard, a rise in the income level enhances an individual is purchasing power resulting in increased demand. On the same note, at the macro level, the GDP affects people's living standards and is, therefore, seen as a trigger of growth of electricity demand (Dahl and Roman, 2004).

It is worth noting that Libya is a middle income country and one of the most industrialised countries in Africa. The economy of Libya is heavily dependent on energy, particularly oil, which provides all export earnings that constitutes about 25 percent of its gross domestic products (GDP). These revenues derived from oil make the country one of the highest per capita in Africa based on the fact that its population is also very low. The country also experiences one of the lowest inflation rates in the world at 2.8 percent according to 2003. At the time, the country was also experiencing an economic growth rate of 3.2 per cent, with purchasing power parity of $35 billion (El-Arroudi *et al.*, 2009). These statistics reveal that the majority of Libyans live above the poverty line and, therefore, can easily afford electric power. Nevertheless, since earnings differ from one individual to another, the demand for electric power also differs.

Generally speaking, income elasticity varies according to the type of commodity considered. In this regard, for basic commodities, which consumers demand more as their income increases, the elasticity is said to be positive. This is in contrast to the inferior goods for which consumers' demand is less as income increases, thereby implying negative elasticity. This is manifested during economic studies of households, which found that the electricity consumption for the rich was far above those of middle and lower class. The studies found that as the incomes increased, there was a positive shift in the demand for electricity as many people could afford electric appliances that consumed a lot of power, thereby resulting in increased electricity consumption. Garen *et al.* (2011) also noted the same during his study of the behaviour of household consumption of electricity in which they observed that a 1 per cent increase in income led to an increase in electricity consumption of 0.13 per cent and 0.43 per cent for fuel oil consumption. These statistics show the magnitude at which the real income of an individual affects the electricity consumption level. This positive correlation is due to the fact that electricity is viewed by the most people as a basic commodity used for both domestic and commercial purposes.

The 2011 Libyan revolution that took place from February to October also confirmed the impact of income on demand for electricity. An economic survey conducted in the year 2012 found that many people stopped consuming electricity as they used to do before the revolt. The respondents argued that the reason why this was so during the conflict was lack of money to pay electricity bills (Bureau of Energy Data and Studies 2004). This was due to the fact that many banks were closed, and people were not able to go to work, leading to an economic downturn. Nevertheless, with the current peace in the country and the fact that the economy has begun to rise, many people now have money, which has seen an increase in the demand for electricity once again. This supports the finding by Jamil and Ahmad (2010) that income and demand for electricity has a positive relationship.

3.3.2 The role of imported appliances on the demand for electricity

Imported electrical appliances refer to the electrical equipment that is not manufactured by the home country but is instead bought from other countries, which are trade partners. This equipment has a lot of impact on the demand for electricity. This is based on the fact that electricity demand is derived demand and depends upon the use of electrical goods and capital stock (Bohi and Zimmerman, 1984). Based on this fact, imported electrical appliances becomes an important determinant of electrical consumption and show a positive correlation. Demand for electricity in Libya has been influenced a great deal by the electrical appliances imported from other countries. This is based on the fact that Libya depends a lot on imported products as it is still behind in terms of technology.

Libya imports approximately 70 per cent of its electrical appliances from other countries. Therefore, as people purchase these appliances for domestic and industrial use, the demand for electrical power also increases. Take, for example, a situation where a company that deals in the manufacture of electrical appliances happens to import several electrical appliances, which are in high demand in the country. Once these appliances have been sold, the buyers will not keep them without using them rather they with source more power to enable the appliances work. This is one of the contributing factors to the rapid increase in power consumption in Libya. This implies that the government of Libya should take into consideration when devising its electricity policy, the impacts of imported appliances on the demand for electricity.

3.3.3 Population growth as a determinant of electricity demand

Population growth is one of the factors affecting energy demand in Libya. According to the current population growth trends, population growth in Libya is expected to increase. While the population growth rates are expected to decline due to urbanisation and increases in education levels, income levels and standards of living, the mortality rates are expected to decrease. Population growth in Libya has been over 2 per cent annually for several years now (Metz, 2004).

According to Evans and Hope (1984) OPEC may turn to nuclear power to help them meet the high demand for electricity which has been brought about by the rise in per capita use of electricity and high population growth rates. The countries that may opt to use nuclear energy to supplement electricity demands include Iraq and Libya (Evans and Hope, 1984). In particular, Libya had requested the USSR to build them a 300MW nuclear energy plant. However, these efforts have been hindered by the suspicion with which the country has been viewed by the Western nations such as the United States and the United Kingdom. In addition, the construction of nuclear energy plants has been affected by a lack of staff capable of handling the technology.

As of 1987, the most recent census to have been carried out in Libya took place in July 1984. However, the only available data showed a provisional population figure of 3.637 million citizens, indicating one of the most sparsely populated countries in Africa. Of the total population figure, men were found to outnumber women. In particular, the number of women stood at 1.687 million while that of men stood at 1.950 (Hess 1988). The population figures did not exert much pressure on electricity production in Libya. However, with the ever-increasing population rate, measures were put in place to provide electricity for most urban residents, alongside the increasing industrialisation in the oil industry (Hess, 1988).

The World Bank had projected that the Libyan population would reach a total of 6 million in the year 2000. This high rate of population growth was expected to reflect an official policy of fostering rapid growth to help the country meet labour needs as well as fuel economic growth. To increase the population and spur development in major growth areas of the economy such as electricity supply, the government had to provide initiatives to encourage its citizens to produce more children. In addition, the government put in place measures to ensure improved health facilities for infant survival. Libyan population policies have over the years stressed the need for growth over restraint; that is, large families over small ones and an ever-improving economy and population. The Libyan government felt that it could afford to satisfy the electricity demands, given the vastness of its wealth in petroleum resources. Much of Libya's electricity is generated by the use of the available oil resources (Hess, 1988).

The population of Libya is mostly concentrated in urban centres, about 65 per cent of the population lives in the capital city, Tripoli (Hess, 1988). With the ever-increasing need to industrialise and the large increase in population, electricity demand has been rising from the early 1950s. In the 1980s Libya could still be described as a predominantly rural country, despite the fact that a larger percentage of its population lived in cities and nearby intensively cultivated agricultural regions along the Mediterranean Sea. Under the impact of rampant rural-to-urban migration, there was rapid growth in the urban sector, thus, leading to increased electricity demand.

The World Bank placed the rate of urbanisation in Libya at more than 60 per cent of the total population. These figures reflected a radical change in the way the urban sector was defined rather than the ever-increasing surge of rural immigrants into the cities and towns. In spite of the large-scale rural-to-urban migration into major cities and towns, particularly Benghazi and Tripoli, the rate of urbanisation in Libya could not be compared to any other Arab country (Hess, 1988).

Population growth in Libya has therefore been increasing the demand for electricity for several years. In addition other factors, such as urbanisation due to rural-to-urban migration, have also put more pressure on the government to generate more electricity to spur economic growth and industrialisation. It is also worth noting that population growth is necessary for advancement in industrialisation since labour can be easily provided by the citizens (Metz, 2004).

For several decades, Libya languished in poverty (Metz, 2004). Many citizens engaged in subsistence farming, which only produced enough food for their survival. In addition, the vast stretches of desert were not important for the cultivation of crops for domestic use and for export. Libya's change in fortune to become a leading industrial nation in Africa occurred after the discovery of oil in 1959. The oil industry led to the production of electricity through the use of oil generators as well as providing employment and high incomes for the citizens. The standard of living increased dramatically, thus, leading to increased population growth rates. Rapid population growth in Libya is expected to reduce the economic growth of the country. The population as of 2004 had reached 5.5 million, and with this population growth rate continuing Libya will not be able to provide enough electricity and jobs for the young members of society (Metz, 2004).

Studies have been carried out in other countries to find the relationship between population variables and electricity demand (Nasr *et al.*, 2000; Holtedahl and Joutz, 2004; Narayan and Smyth, 2005; Zaman *et al.*, 2012; Blázquez *et al.*, 2013). Nasr *et al.*, (2000) used econometric models to investigate determinants of electrical energy consumption in post-war Lebanon including population and GDP proxied by total imports on electricity consumption over different time spans covering the 1993-1997 period. They found that all electrical energy consumption determinants were significant at the 5 per cent significance level. In addition, cointegration analysis revealed the existence of a long run relationship between all variables (including population).

3.3.4 Economic growth as a determinant of electricity demand

The expansion of the Libyan economy depends strongly on the rate of oil income. Oil prices have been a major determinant of economic growth and generation of energy. Libya already has a large amount of electrical generating capacity in place or under construction. However, if economic growth continues in the same manner as witnessed in the 1960s, the demand for more electricity will be affected (Malcolm and Losleben, 2004).

The structure of economic growth has also affected energy demand in Libya. Over the past few decades, Libya has invested in industrialisation initiatives. Development strategies favouring industrialisation and urbanisation require more electricity, thus leading to increased electricity demand. Development strategies stressing agriculture and service sector development, however, do not require large amounts of electric energy. In particular, during the early stages of industrialisation and oil exploration, there was increased demand for electricity and its consumption. Apart from Libya, other Middle Eastern nations that had invested in heavy industrialisation experienced more rapidly rising demands for electricity (Malcolm and Losleben, 2004).

3.3.5 Industrial sector

The industrial sector in Libya is crucial for the economic growth and electricity demand. In 2003, the demand for energy in the industrial sector was 4 million tonnes of oil equivalent. The demand for energy is expected to increase to 11.2 million tonnes of oil by 2030, thereby forcing the government to find alternative means of generating electricity other than relying on oil resources. The promotion of downstream industries has increased electricity demands in Libya over the years. Despite the need for large investments in constructing large petrochemical plants and the slow progress in expanding the industry, the demand for electricity continues to rise (Evans and Hope, 1984).

The Libyan economy has also faced several challenges. In particular, the United States trade embargo, which was introduced in 1982 affected Libya’s economy, thus, leading to low investment in the electricity production sector by foreign investors. In addition, the United Nations’ sanctions in 1992 had massive effects on the Libyan economy (Evans and Hope, 1984). Some of the effects included the decline of living standards and the lack of basic human needs. Gaddafi’s attempts to spur economic growth and make Libya self-sufficient became futile although a few foreign investors continued to invest in the country. Low investment during this period led to low demand for electricity in Libya. After the suspension of the United Nations' sanctions in 1999, life for the citizens improved as the economy began to thrive, leading to more investment in the electricity production sector through the use of the available oil resources (Evans and Hope, 1984).

It is worth noting that, Libya has iron and steel industries, aluminium plants, and chemical industries (Otman and Karlberg, 2007). The operations of these industries have led to increased demand for electricity for their efficient operation. In addition, electricity is used in the most important industries in charge of the processing of foods such as tomato paste and tuna. Other processing industries include soft drinks, tobacco, clothing, footwear, leather, wood, chemicals, and metal goods, which require high electricity voltages (Otman and Karlberg, 2007).

The emphasis on petroleum and industry has led to increased electricity demand and an increase in the number of Libyans living near Tripoli and Benghazi. The increase in electricity demand has also been brought about by the oil exploration activities. Libya has the largest underground oil reserves in Africa and the eighth largest in the world. The exploration of such huge oil resources required a steady supply of electricity. After the suspension of UN trade sanctions in 1999, several European and Arab countries resumed drilling and refining operations in Libya (Otman and Karlberg, 2007). This led to increased demand for electricity. President Gaddafi had also invested heavily in the construction of more oil refineries and pipelines. The petroleum exploration activities are some of the determinants of increased demand for electricity in Libya (Otman and Karlberg, 2007).

3.3.6 Environmental factors affecting electricity demand

The need to produce clean energy that does not emit carbon dioxide, carbon monoxide and sulphur dioxide continues to affect electricity demand in Libya. With the current climatic changes affecting the environment, there has been a growing need to shift from non-renewable energy sources to green energy such as solar and wind energy. The world has had to engage in several conventions aimed at curbing carbon emissions into the atmosphere. The Kyoto Protocol is an example of a conference at which the world has tried to agree on minimising the emission of harmful gases into the atmosphere. Libya is one of the nations that have continued to rely solely on carbon fuels, thus, contributing immensely to environmental degradation. Global pressures and sanctions have deterred further investment in electricity generation using fossil fuels in Libya.

According to Smith (2012), scientists warn that the earth is already certain to experience an average 2^0 C temperature rise. The temperature rise is due to global warming. The depletion of the ozone layer due to ozone smog has led to global heating. Global heating refers to excess solar radiation which is harmful to all living things on the earth. Global warming, however, can be seen as a consequence of solar radiation. Global heating and global warming must be prevented by halting the generation of electricity from fossil fuels. Furthermore, global warming is the result of solar radiation being reflected back into space, leading to the heating of the atmosphere in the process.

Air pollutants, especially when they exceed certain concentrations, lead to acute or chronic diseases. The fact that electricity is generated through the use of fossil fuels has prompted environmentalists to find alternative, cleaner energy sources, thereby reducing the non-renewable energy demand in Libya. The effects of air pollution and environmental degradation are very serious. Air pollution impairs visibility as well as leading to climatic changes. Adverse health effects on human beings can affect productivity in economic activities. Reduced economic activity due to an ailing nation further affects the demand for electricity. Despite the need to reduce air pollution, over the years the Gaddafi government failed to take sufficient measures to improve the situation. Oil exploration has been given prominence over the need to reduce environmental degradation. To prevent further environmental degradation due to electricity generation by the use of fossil fuels, as in the case of Libya, each country must be made responsible for its actions (Ham, 2007).

3.3.7 Insulation/heating demands

Haller (2007) asserted that there is growing need to conserve energy in Libya and in other parts of the world. Energy conservation depends on the insulating and weather-proofing activities put in place in various homes. Members of the public have been advised to purchase energy star certified (high efficiency) appliances. These devices conserve electricity by ensuring that homes consume electricity in the smartest and most economical manner as well as being environmentally friendly. The main benefit of cleaner, greater energy efficient appliances is that they give consumers' the opportunity to use less electricity. In addition, these appliances minimise the energy used in homes. Energy saving tips save money as well reducing the over-reliance on fossil fuels. The implication of using less fossil fuel is that there will be less emission of carbon dioxide which is harmful to the ozone layer and a major contributor to climate change (Issar, 2010).

Due to the high temperature in Libya, there is an urgency to insulate walls and ceilings. The insulation processes have led to increased demand on electricity. According to Wijen *et al.*, (2012), insulation initiatives reduce home heating costs and home heating bills by ensuring that less carbon dioxide is emitted into the atmosphere. Furthermore, non-use of electric heaters in Libya due to high temperatures has led to low power bills in homes. Insulation is critical in preventing the effects of extreme temperatures. Other electrical appliances such as fans continue to be used extensively to cool the houses which experience high temperatures throughout the year. The use of electrical appliances and the construction of more petrochemical plants as well as industries had led to increased demand on electricity for several years (Issar, 2010).

3.3.8 Electricity demand factors from government energy policies

The history of government involvement in Libya's national energy industry began with the liberalisation of national politics after Muammar Gaddafi took power. In view of the commitment of post-colonial governments to development projects led by the African Arabs, Libya set the pace for the rest of Africa, making huge strides in the provision of accessible energy at the household level. National policies for distribution of electricity in Libya provided a model for development in terms of a cheap and readily available power supply. Despite misgivings about the Gaddafi regime during its four decades in power, culminating in the toppling of the leadership in the Arab Spring, Libya's national power supply supported by government policies has been an outstanding achievement (Al-Qatha, 2006). One prominent feature of the regime was the highly subsidized electricity pricing policy that the leadership stuck to for a long time (Al-Qatha, 2006). In view of the incentive impact generated on electricity consumption as a function of subsidized power rates, the government of Libya exposed the overall demand to inflated trajectories for the entire period that the subsidy was in place.

Development of and research into infrastructure to raise the government's capacity to keep up with the pace of development in the Arab region illustrates the regime's connection with the pace of distribution of electricity. Demand for power increased tremendously in Libya following the government's declaration of free connectivity in many regions (Vandewalle, 1998). The equitability of the power distribution policy could be questioned but the underlying commitment of the government to provide power to meet the national demand is commendable. It is commonly believed that Muammar Gaddafi rewarded certain regions and punished others for sectarian political reasons but the overall national demand for electricity grew despite the regressive policies (Vandewalle, 1998). Due to the regressive political policies that eventually led to Gaddafi's overthrow and ultimately to his death, demand rapidly exceeded supply due to the government's neglect of national interests (Vandewalle, 1998). Huge incomes generated in the energy sector might have provided the required development track in order to give the nation sufficient energy but the government never kept up with the pace of the demand over a couple of decades. Perhaps the worst stretch of interaction with retrogressive attention to electricity supply to meet the demand emerged in the early 2000s when the country was plunged into a series of chronic blackouts(Clough, 2008). Such an instance occurred in the summer of 2004 when a virtual blackout engulfed the country since the small number of power-generating plants could not satisfy the mammoth demand across the country (Clough, 2008).

Trade and investment in the region grew during the period when the Libyan energy sector became integrated in regional trade protocols, as an illustration; the membership of and subscription to the OPEC body opened up international cooperation in terms of crude oil resource development. According to global business rankings, Libya's position in terms of preferred investment destinations is poor regarding its attractiveness to spur development likely to improve infrastructural connectivity such as electricity (Firebaugh, 1992). As a leader in the exploitation of natural crude oil endowment in Africa and perhaps in the world, Libya has attracted numerous investment projects from foreign countries, thereby opening up the country for business. Industrial development took shape due to the growing investment opportunities that the international community continued to identify in the country (Pargeter, 2010).

Exploitation of the country's huge deposits of natural resources such as oil and gas likewise had a direct impact on the energy sector (Firebaugh, 1992). Although Libya is located in a climatic zone that does not allow hydroelectric power projects, unlike many other African economies, it managed to convert its oil and gas products into electricity. The conversion of natural gas into a turbine energy-developing resource enabled the country to continue raising its capacity to meet the ever-growing demand for energy. Long spells of government interference in investment activities and a lack of public and private partnerships imply that the state of affairs regarding the involvement of foreign companies cannot be compared to model settings (Pargeter, 2010). The traditional business culture and competitiveness bear the scars of a sceptical business community in a country where the nationalist ideology created by Gaddafi's regime painted a negative image of foreign involvement in business.

Conscious of the creeping un-sustainability of the industry, the country made several arrangements on the international cooperation platform to rescue the state of power sustainability. Numerous projects to raise the capacity for meeting the demand have been initiated in many parts of the country (United Nations, 2009). The overall impact of the government's commitment to embark on production capacity enhancement raises the trust of investors and domestic users alike.. Commitment to the harmonisation of energy policies in the region, particularly in the Arab and OPEC nations, pressed the government to continue paying attention to electricity production sustainability. Parameters of specific investment in electricity projects as motivated by demand illustrate the huge potential of the country to ensure a constant supply of power across all installations at industrial and domestic levels. Projects such as Western Mountain Gas Turbine Plant with a capacity of 4x165MW, Zawiya Power Plant Gas Turbine Extension with a generation capacity of 2x165MW, the North Benghazi Combined Cycle Power Plant whose capacity is 2x150MW, and Zawiya Combined Cycle Power Plant, the West Tripoli Power Plant Extension, at 2x325MW led to increased production to meet the demand (EIA, 2012).

3.3.9 Pricing factors

Involvement of private and public partnership in Libya indicates the level of demand in the country, to keep up with the pace of socio-economic development. In terms of sustenance of investor confidence in Libya as the investment destination for the region, electricity demand projections compel certain policies. Following the government's commitment to provide electricity on the people at a highly subsidised rate, it is expected that the overall impact generated to the household's propensity to such connections grew over the years for the country (Komoto, 2009). Perhaps the over stretching demand against restricted supply was a product of the continued supply of electricity at a reduced cost. It implies that the overall social cost of connectivity provided the motivation to stick to a subsidised connection.

Involvement of international players such as Italy's Enelpower, Russia's Tekhnopromexport, South Korea's Hyundai, Spain's Abengoa and Cobra, France's Alstom and Nexan's among many other multinational companies explain the public-private partnership and cooperation (Komoto, 2009). With such an expansive partnership, Libya's energy consumption improved tremendously since the earlier uncertainties were taken care of considerably. In view of the international players' interest in Libyan energy resources, co-operation for enhancement for the electrification programs from the foreign players can only raise the demand projections for the country for the entire period.

Market parameters of demand across the country expose the demand variables to difficulties beyond physical practicality and logical benefits of connectivity (DeMello, 1997). Due to the climatic factors witnessed in the vast geographical area of the country, arid and semi-arid conditions discourage human settlement in areas towards the south of the country. It, therefore, implies that despite the location of land for potential green energy projects such as solar energy generation to the south, consumption is relatively scanty in the south when compared to the north where human population is denser. In view of the geographical constraints of supply to the south, it would be practically impossible for the government to supply electricity to a few locations as opposed to the more populated locations in the north (Hoekman, 2000).

Population distribution factors affected by projections of movement and migration from rural to urban locations also causes demand to be congested in certain areas. Just as in any civilisation powered by energy solutions of different forms, it is a common feature in Libya that development projects follow human population patterns with the scarcely populated falling low on the concentration of connectivity to networks of support services and infrastructure (Hoekman, 2000).

Libya's reliance on resources generated from natural raw materials such as oil and natural gas to deliver electricity without an edge on technology solutions affects patterns of demand and supply (Hoekman, 2000). Development of capacity at the national level to provide capacity to embrace technologies that can facilitate conversion of greener resources of energy into sustainable and safe electricity has faced a hindrance due to other development demands.

Redirection of revenue to the most costly social projects such as security and public service remuneration makes it impossible for the country to develop sustainable capacity to overcome demand across the country. As an illustration, various factors emerging from geographical location in the dry climatic conditions make it imperative that food security is affected by lower production capacity (Hoekman, 2000). Directing considerable resources to provision of food security from purchases and unconventional agricultural projects implies that the electricity development trajectories suffer from other spending needs. This skewed resource allocation implies that the demand and supply imbalance exposes the sustainability of the industry needs to challenges that only technological advancement can resolve (Hoekman, 2000).

Production cost of electricity in Libya is perhaps better than in many regions in the world due to the availability of oil as a raw material in many electricity production products. In view of the cost burden passed on to electricity consumers, it implies that the charges fall below the generally expected range. The element of production cost passed on to the consumers is reduced and reclaimed from the huge sales realised from the many oil fields in the country. This concept of pricing reduces the rates charged to Libyans in their energy bills (Joffé, 2001). Coupled with the government commitment to provide subsidised connectivity, the demand for electricity in the country obtains assurance from the projected quantity of oil deposits in the country. However, traditional constrictions to development in the developing world put exponential growth in electricity production and distribution into a disadvantageous position when compared with the rest of the developed world.

3.3.10 Lifestyle factors

The cultural contexts of the Libyan population can facilitate the characterisation of the Libyan people in terms of the inherent demand for energy. Based on the industrial status of the country, a third-world level with a lot of potential for economic and industrial development in the future, places electricity demand on an upward curve (Issawi, 2006). In view of the numerous natural resource deposits in the country, the ambitious state of exploitation and development of all sectors of the nation illustrates the demand parameters that stand to increase, as observed in all industrialised nations. Industrial demand is, therefore, not stretched to the levels of other industrialised nations, which makes the case for an increased demand for electricity to support industrialisation. Projecting the development requirements of African nations in order to catch up with the rest of the world in operations and the embracing of technology, electricity demand will continue to increase.

Domestic use of electricity in Libya is affected by a few factors that interact with socio-cultural variables and economic potential. Socio-cultural factors, including the Arabic tradition of urban lifestyles, imply that the use of electricity in the urban lifestyle is greater than in ordinary African settings. Compared with other African lifestyles, the Arab way of life with its preference for an urban setting increases the consumption of electricity needed to support the urban lifestyle (Joffé, 2001). The management of numerous housing needs in an urban setting considerably increases demand for electricity when compared with a rural setting. With a huge section of the population being composed of young adults and children, it is likely that the use of electricity in the modern technology age is a necessity (United Nations, 2009).

The skewed distribution of population to the north of the country exposes the south to a chronic shortage of electrical connections, discouraging any investment consideration in the sparsely populated regions (United Nations, 2009). Demand for electricity in the urban centres is likely to increase for a considerable length of time until rural and urban disparities in the provision of social amenities are eliminated through appropriate development. In view of the political transformations experienced recently in the country, development projects will continually lay claim to the national kitty during allocation since representation in national issues has taken on an equitable format (Goodland, 2008).

When compared with the rest of the African population, Libyans enjoy a better connectivity and use of electricity. The African context elevates Libya to a position slightly ahead of the rest of the nations in terms of endowment with natural resources. Libya, as one of the world's leading producers of energy products, enjoys a comparative advantage in the number of options available to spur development across a country heading towards industrialization (Issawi, 2006). Despite the fact that the investment environment in the continent falls short of the model standards set by the international business community, Africa possesses untapped potential, which can only raise opportunities for investment.

The development factors that define the African context still play a role in the demand variables in Libya and other African oil producers that would otherwise be expected to have made tremendous strides out of poverty. The state of socio-economic and political underdevelopment in Africa characterised by low levels of education, poor social services, and poor or non-existent leadership and institutions continues to compromise the status of African countries as world leaders in energy technology and utilisation (Goodland, 2008).

The environmental energy consumption demands of households in Libya are based on a hot and dry setting that exposes the housing needs to specific demands for electricity. Electricity needs in the environment, for instance the need for cooling installations in the hot arid environment, comprise a significant consumption component since the summer lasts longer than in Europe (United Nations, 2009). Heating energy uses, however, do not represent a huge component of electricity consumption since cold temperatures in Libya do not warrant such consumption needs.

As an illustration, the cold winters experienced in Europe are not an extreme event in the hot environment that Libya enjoys with the rest of the North African nations.

However, recent changes in climatic conditions pose the threat of uncertain weather patterns, and demand for cooling or heating may increase significantly over the coming years (Goodland, 2008). Conservation awareness and commitment to supplying home appliances regulated by the government and authorities in Libya have a long way to go before they attain levels prescribed by global standards.

Libyan society's propensity to conservation practices defines the demand for electricity across the country's installations. Apparently, the state of awareness of conservation practices in a population that is largely below internationally set standards of living falls short of the desired practices (Joffé, 2001). The culture of energy conservation can be projected as lower than in the developed world due to a number of other factors alongside awareness. Conservation programs across the world have adopted the green revolution, and abandoning fossil fuel as the sole source of energy is the new approach embraced to implement the green revolution.

Libya's reliance on gas and oil for the generation of electricity implies that the country must make a sudden departure through technological advancements to realise the projected reductions in emissions from fossil fuels (Goodland, 2008). Considering the current application of alternative technologies in the production of green and renewable energy, Libya's capacity to meet energy demands through cleaner energy is below sustainable standards. National capacity to deal with the internationally acclaimed green revolution and still meet the entire demand for electricity in Libya is, however, attainable to a better extent than in many nations of the world.

This is due to the huge potential for solar and wind energy generation conferred by Libya's expansive geographical advantage and its supportive climatic attributes.

Libya's peripheral role in the transformation of global fossil fuel consumption is perhaps attributable to the traditionally isolated role that Libya has played in many international issues as a consequence of its political environment (Dupree, 1958).

3.3.11 Political factors on supply

Contrary to current debates on Libya when comparing the country to the rest of Africa, Libya's energy distribution and other infrastructure thrived for a considerable period. The housing policy, whereby the national government provided houses to newlyweds, propelled the development of the energy sector in ways that many would not comprehend. Unequal distribution of national resources across Libyan communities, however, resulted in the Gaddafi regime's plan lacking credibility considering the priorities facing the government. Authoritarian leadership in the infamous regime exposed the country to several years of regressive programs that benefited Gaddafi loyalists, with the consequence that electricity demand was not an important supply-driving factor for the government. Political contribution to the variables of a country's demand for electricity touches on policy formulation and political motivation underlying national decision-making (United Nations, 2009).

Politics under Gaddafi's regime exposed the country to a number of undesirable factors; the country might otherwise have been propelled to adopt the required development standards in its electrification environment. Libya's approach to dealing with the international community could not facilitate the desired level of interaction and cooperation to spur development to meet electricity demand (El-Farisia, 2003). A regime critical of the Western community in several perspectives could not facilitate the appropriate capacity enhancement to deal with infrastructural development needs.

Despite the fact that the trade environment established in regional agreements enabled the government to undertake basic disposal of produced oil resources, it was difficult for the country to enjoy a completely free market, as the history of sanctions on Libya illustrates (United Nations, 2009). A bad international image created through a number of internally and externally damaging interactions with the West shows that progressive co-operation could not be facilitated as Libya attempted to compete with other oil-producing countries in raising standards of living. Perhaps a better political experience for the country could have generated a bigger growth in electricity demand, a view that can be constructed from the unpleasant operations' environment (El-Farisia, 2003).

Projections of industrial and domestic electricity demand under the new political regime following the Arab Revolution are preparing the country for exciting times in terms of industrialization demands. A civilian regime is expected to represent the aspirations of the nation in contrast to the authoritarian regime that rewarded and punished regions and communities at will (EIA, 2012). The elections held in Libya since independence prepared the country to come to terms with democratic opportunities for development where services such as connectivity to electricity form part of government policies as an undeniable right. Demand for electricity is therefore projected to accelerate if the democratic environment continues on an upward trajectory, leading to a liberal approach to even distribution of resources across the country (Dupree, 1958). Energy industry management at the national level is likewise expected to attract expertise and professional input, thereby increasing incentives from several perspectives.

3.4 CHAPTER SUMMARY

In this chapter, the theme of determinants of demand for electricity was highlighted by defining characteristics of electric power, exploring the factors that are considered to have a potential impact on the demand for electricity and highlighting the research approaches used to study electricity demand variables. The literature reviewed suggests that identifying the factors influencing the demand for electricity depends on the environment of the country under study. In addition, the chapter highlighted a number of empirical studies of some previous studies of the demand for electricity. The next chapter will examine in detail the methodology conducted to carry out this study, including the quantitative method and the qualitative method of the case study.

CHAPTER FOUR: RESEARCH METHODOLOGY

4.0 INTRODUCTION

This chapter covers the procedures used in analysing the collected data and presentation of the data. It, therefore, focuses on the research design employed and analysis adopted during the research process. Presenting these components will clarify how the data was analysed and inferences made and how such inferences can be used as the starting point for addressing the research topic and main objectives. The chapter commences with a debate on reasoning methods, research philosophy, research techniques, research strategies, ethical procedures, research limitations and methodological issues of this research, then the qualitative and quantitative methods followed by analysis of the data collection methods and a framework for data analysis; following that, the research methods adopted of the verification and validation process in this study.

4.1 REASONING METHODS: DEDCUTIVE AND INDUCTIVE

When conducting research, there are two broad methods that are available for researchers on how to approach the research including inductive reasoning and deductive reasoning. Copi *et al*. (2007) defined inductive reasoning as making broad generalizations from specific observations of an identified phenomenon. When using the inductive reasoning Holyoak and Morrison (2005) observed that the main aim is to develop a hypothesis or a theory based on the identified phenomenon and the relationship between identified variables. As also explained by O'Leary (2007), even with the truth behind some research statements, the inductive reason may prove otherwise and develop a false conclusion. For instance, in this study, the conclusion that the cost of electricity affects the usage among Libyans may be true but an inductive approach may prove it as false based on the hypothetical conclusions.

Deductive reasoning is defined by O'Leary (2007) as the use of an existing theory or hypothesis to evaluate an identified phenomenon. In the context of the current study on electricity demand in Libya, the deductive reason could not adequately apply. Though Holyoak and Morrison (2005) observed that deductive approach promotes valid reasoning, the context under which it is applied should be a phenomenon that is adequately covered across the research field. O'Leary (2007) highlighted that deductive reasoning uses general statements to make conclusions, which is why it is best in testing a theory or an identified hypothesis. A major observation in deductive reasoning is that it makes general conclusions. For instance, if a statement in this study indicates that electricity demand is determined by the level of income, then it will be generalised that all people across Libya consider their income when making demand for electricity. This might not be true, which is why the current study did not prefer deductive reasoning.

The major difference between inductive and deductive reasoning is that the former is used to develop a theory or hypothesis, while the latter is used to test the theory or hypothesis (Copi *et al.,* 2007). As also noted by O'Leary (2007) deductive reasoning is used in research when the phenomenon is explored in-depth by previous scholars and adequate knowledge developed on the given phenomenon. This is different from inductive reasoning because it is common in research scenarios where the identified phenomenon is not adequately explored and required additional knowledge to develop any hypothesis or theory.

For the purposes of this study on electricity demand in Libya, inductive reasoning was adopted. This is because there is no adequate knowledge on the phenomenon and in-depth search of information was required. Based on the fact that the study was aimed at hypothesising the difference in electricity demand across Libya, the inductive reasoning was more effective in approaching the study to develop a hypothesis in relations to the topic. The inductive approach was used to evaluate the collected data, identify the different variables that relate to electricity demand in Libya, and hypothesize on the different factors that determine the demand for electricity in the region. The current research also preferred inductive reason because it leaves room for a critique of the findings on the hypothesis or theory.

O'Leary (2007) observed that inductive reasoning allows for major recommendations for future research in evaluating the reliability of the identified research findings. Especially in a research field such as electricity demand in Libya, where not much has been done in relation to knowledge development relating to the issue, inductive reasoning was considered as appropriate in supporting further probing in future studies.

4.2 RESEARCH PHILOSOPHY

A review of the works of BonJour (2002) on research methods reveals that researchers have different research philosophies that they can adopt depending on the nature of their study. The different research philosophies include ontology, axiology, and epistemology. The current study adopted the epistemology philosophy. To understand the reason for the preference of the epistemology approach, definitions and explanations of the different philosophies are discussed in this section.

Harvey (2006) defined ontology as a description of the nature of reality as created in the individual minds. In further describing ontology philosophy, Harvey (2006) observed that it involves a classification of entities and how they can be grouped to differentiate them. For instance, the researcher could have evaluated different factors that affect electricity demand in Libya and differentiated them based on their similarities. However, this study was not about identifying and differentiating entities, which is why the ontological approach was not adopted.

From a different perspective, axiology is defined by Hiles (2008) as a scientific approach that evaluates the individual thinking of people. Hiles (2008) further observed that axiology is concerned with the meta-scientific world views of an identified phenomenon. Axiology is also adequately discussed as an approach that evaluates the different approaches that individuals take in determining the value of things. The individual values relating to an identified phenomenon are measured and compared based on the axiological approach (Kelleher, 2013). However, with this study, individual thinking was not the main focus of the study, which disqualified the axiology philosophy. The main focus of this study was to evaluate the phenomenon as it exists in the natural setting. The study aimed at understanding the demand of electricity in Libya, which is not an issue that requires an evaluation of people's thoughts, but the analysis of the phenomenon as it exists.

A rather more appropriate research philosophy that was adopted in this research is the epistemology philosophy. As identified by Kornblith (2001) epistemology is a branch of science that is concerned with the existing knowledge of a given phenomenon. The philosophy aims at acquiring knowledge of a phenomenon as it exists within the natural setting. Epistemology according to BonJour (2002) also focuses on creating knowledge of an area of inquiry based on the perspectives of the existing information. For the purposes of this research, the aim was to enhance the creation of knowledge on electricity demand in Libya. A preference for the epistemology philosophy was based on its strength in furthering the understanding of electricity demand based on the available statistics and the knowledge from the main research subjects.

4.3 RESEARCH STRATEGY

Different research strategies have been used in the field of research to evaluate different phenomena. Among the common strategies used in the research field are scientific research, action research, ethnography, phenomenology, and grounded theory. To make a decision on which research strategy to use, the nature of the current research had to be considered. At the same time, the different meanings and applications of the research strategies were also developed.

A definition of the scientific research strategy by Gauch (2003) highlighted it as the use of experimental trials to test an identified hypothesis. Conversely, Bynum and Porter (2005) observed that in conducting scientific research the investigation of a phenomenon uses empirical and measurable evidence relating to the phenomenon. In this case, a theory or hypothesis has to be confirmed or challenged based on the findings resulting from the evaluation of an identified phenomenon.

Therefore, when adopting a scientific research strategy, the subject must engage trials in providing or disproving a hypothesis or theory (Gauch, 2003). In this research, the aim was not to conduct a test or challenge a hypothesis on electricity demand in Libya. But the study used a scientific research approach because it aimed at explaining the phenomenon and exploring the issues and details that surround it and presenting the reality on the ground.

Action research has also been preferred in other scientific studies. It is identified as an approach in the field of scientific research used in developing a solution to an identified problem (Atkins and Wallace, 2012). In action research, individuals work in teams to identify a problem and then embark on the practice of solving it. In conducting action research, Reason and Bradbury (2001) observed that the main aim of the participants is to create change and implement it within a social setting. The common use of action research is by large organisations to identify a problem within the workplace, and engage the workers in planning on how to solve the problem.

Atkins and Wallace (2012) noted that action research is based on already acquired knowledge relating to a particular research problem. This study did not aim at solving problem, the research topic was mainly focusing on exploring and presenting the natural state of the phenomenon on electricity demand in Libya, the study was focused on creating knowledge of the identified phenomenon. However, action research could have been applied in the context of the study, because the study presented a proposed framework for electricity organisations in Libya through presentation and discussion of the results of the study with the participants for further exploration of the opinions of experienced personnel towards the usefulness and appropriateness of the proposed framework in practical reality.

Another method common in the field of research is ethnography. Richardson (2000) defined ethnography as a research design aimed at exploring an identified phenomenon from the perspective of the research subjects in their natural setting. Richardson (2000) added that ethnography aims at understanding a cultural group in terms of their beliefs and values. Ethnography addresses a phenomenon from individual reflection of experiences (Gubrium and James, 2009). Therefore, in efforts to understand the social life of humans, ethnography is identified as the most appropriate method of inquiry. According to Gubrium and James (2009) ethnography is an account of things from the perspective of the identified research subjects. The main goal of ethnography is to collect and analyse data with the minimal bias possible. The researcher's perspective in this case is not considered for applied the data collection of analysis.

The data collected through ethnography is basically presented in its raw form to help explore a phenomenon in-depth. Richardson (2000) observed that in facilitating ethnography, different data collection methods may be used depending on the nature of the research to develop a portrait of the research subject and paint the picture of the entire community based on the basic portrait. This study adopted the ethnographic approach with the aim of understanding the demand for electricity and determinants of electricity projects in Libya. The main focus of the ethnographic approach was to collect data and present the situation on the electricity in the region.

Phenomenology is also a research strategy that has been predominantly used in the field of sociological and business research. As observed by Boyd (2001), phenomenology is a research strategy that aims at understanding the personal experiences of research subjects regarding an identified phenomenon. Caelli (2001) also observed the interest of phenomenology as based on structures of experience, or consciousness. Therefore, the approach is commonly used in studies where the researcher seeks for an account of personal experiences regarding an identified phenomenon. Moran (2000) added that things as they appear in the perspective of the research subject can reliably be evaluated using a phenomenological approach, the phenomenological approach was adequately used in the study because one of the objectives of the study was about personal knowledge and experiences. The study aimed at presenting knowledge on the effect of internal/external determinants of electricity projects as they exist within Libya.

Finally, grounded theory is also accounted for among the main research strategies. Allan (2003) defined grounded theory as the generation of a theory or hypothesis from the collected data. Kelle (2005) added that in adopting grounded theory, both inductive and deductive thinking are required. This is because the inductive thinking helps in developing a theory from the collected data and the deductive is used in testing this theory (Charmaz, 2000). From a different perspective, Kelle (2005) observed that in grounded theory, conceptual ideas about an identified phenomenon are important to support theory building. A comparison of the conceptualised data as collected from the research subjects is facilitated to build the theory. However, in the context of this study, the main aim was not to test the theory by evaluating individual accounts of experiences, which meant that the grounded theory could not be adopted to facilitate this study.

As mentioned above this means that a number of research strategies were applied in this thesis. At first, to achieve the main aim, given that the information was quantitative in nature (detailed narrative information), the structural analysis approach assisted in this to make the study successful. The study used the application software STATA to help when it comes to the estimation and analysis of the function of the demand for electricity in Libya. This software is important it helps for the econometric analysis of time series data, for estimating purposes of the function, where has been estimated the demand function for electricity for the period (1980-2010) using the method of least squares technique (OLS) (Ordinary Least Squares), using the econometrics model where the quantity demanded of electricity is dependent variable and the rest of the variables used in this study as independent variables (see Appendices A to J - The used data in the estimation of the function), and also was conducted test co-integration, Granger Causality and statistical tests such as the *t* -test and F -test.

Secondly, the data applied survey methods to administer the questionnaire to the participants. This was done in a structural manner to make it easy and simple to answer the questionnaire (Weis and Fine, 2004). The secondary information which was applied was obtained from the historical data which is presented. The literature review discusses some of the information which is already there in the journals. The literature extends further to analyse the content which is presented in the information. The content analysis method assisted in this and discourse analysis assisted in putting the information into focus. The questionnaire was designed to have open ended questions. This is the technique of gathering of data in a part of the study and is mainly focused on the real significance of various observations which are made in a specific study as opposed to the specific assigned raw numbers. It involves investigative methods which entails interviews and even detailed case studies (Creswell, 2009).

The surveying method whereby a questionnaire was prepared to handle and discuss some of the questions. The Simple sampling method was used. Sample is the number of selected units to participate in the survey from the General Electric Company of Libya (GECOL). The survey had aimed at interviewing a census of 30 which includes head managers, managers, technicians, engineers, technicians and other staff members. Simple random sampling will be applied to sample the study. These are people who have professional understanding of issues to do with electricity and are either involved in policy formulation or in the construction of the projects. A simple random sample is defined as a subset of participants picked from a large population. Ten interviews with the participants were held to collect data to examine the effect of internal/external determinants of electricity projects in Libya, and twenty participants were formed into focus groups in order to validate results of the study to identify the participants opinions on the framework components towards the usefulness and appropriateness of the proposed framework.

Sampling is delineated as a process which is used in a statistical analysis whereby a given predetermined figure of given observations will be taken from very large sample of population. The specific methodology which is used to sample a given large population will depend on the specific type of analysis which is being performed though it will include simple random sampling, observational sampling and systematic sampling. It is required that when one is taking a sample from a very large population, it is often necessary to consider how the specific sample will be drawn. In order to get a representative sample it is necessary that the sample is drawn randomly. Simple random sample is defined as a randomly selected sample which is obtained from a big sample or even a population that gives all individuals equal chances and opportunity to be chosen. In simple random sample, individuals are picked at random and not more than once to prevent any level of bias that might negatively affect the validity of a particular result of an experiment (Weis and Fine, 2004).

The random sampling is derived from the concept of general sampling procedures which is called the probability sampling. The procedures must be included in four major criteria which include (Neils, 2003):

- Being in a position to define the number of distinct samples whereby the procedures can be selected;
- Every possible sample will be designed to know the probability of selection;
- A need to select samples through random processes whereby every sample gets appropriate probability of selections; and
- The method of computing the required estimate should result into a unique estimate for any specific given sample.

4.4 RESEARCH QUESTIONS

As stated previously, electricity plays a major role for any economy to grow. The demand for electricity has been increasing in the country and the trend has kept the government worried. There are a number of factors which have been discussed, affecting the demand for electricity in the country. The investigations in the study focused on investigating some of the determinants of electricity in Libya. The first question that the study tends to investigate was how, and the level of magnitude by which income, population, price, temperature and appliance imports affect the demand for electricity in the country.

It is worth noting that price is a major variable in the economy. Economists have argued that when the price of a product increases then its demand will come down and the reverse is true when the prices have gone down. The change in price offers a good opportunity to measure by what level the demand of the product has been affected. An upsurge in population will see the demand for electricity in a country increase (Pilot, 2006). Libya has recorded a constant growth in its population since independence and this has seen the demand for electricity going up. The electricity consumption has been increasing resulting in increased demand for the electric supply (Ahmed, 2005) the ability of an individual to afford some of the basic needs fully depends on his/her income. When a number of people have a high discretionary income then it is likely that the demand for electricity will be high. Low income earners in the economy will not be in a position to demand electricity.

Therefore, as the economy attempts to grow so will the populace have the flow of money in the economy. Most business start ups will require electricity and therefore the level of demand will increase. The availability of the appliances will influence the demand for electricity (Costa and Kahn, 2010). Most of the electrical appliances are imported from other countries, therefore when the import duty is high then the electricity demand will come down. Finally, economists have also been arguing on the role of temperature on the demand for electricity. Some have argued that when the temperatures are low then the demand for electricity will be high as opposed to when it is high (Al. Azzam, 2002).

The second question that the study has attempted to answer is on how there can be improved accuracy on the said demand function when it comes to tracking of the realised demand. Given the fact that there are a number of variables affecting the demand for electricity in the economy a number of quality control measures should be put in place to enhance the level of accuracy on the discussed demand (Robbins and Publications, 2007).

The third question that the study has been discussing is on how we can do the comparison on the ability to track the electricity function in Libya in relation to other models which by all standards claim to be tracking the consumption of the electricity (in Libya). The study adopted a model in comparison to other models to help in checking on the efficiency of the model and its ability to explain the consumption of electricity in Libya (Vagliasindi, 2012). The fourth question proposed that has been explained by this study is to investigate whether the econometric models of the electricity demand in Libya is capable of performing a better job when it comes to tracking the consumption of electricity in the country. The discussion in this study is convinced that the model was the best on offer given the fact that it entails some of the major variables which influences the electricity demand in the country.

After highlighting the demand for electricity, the study looked at the supply side of electricity, the fifth question that has been examined by this study is the reconnoitring what are the internal and external determinants of electricity projects in Libya and exploration what is the effect of these determinants on electricity projects in Libya, in order to have a look on the supply side of the electricity in Libya.

The study's main intention was to investigate some of the main determinants of the demand for electricity in the country. It is only through the solutions and knowing these factors that the government can be in a position to address some of the issues. Adopted recommendations will help in controlling the demands so that the equilibrium takes into consideration both the demand and the supply.

With these stated questions, the study holds that there will be a proper insight when it comes to the discussion section. This has helped in drawing on a conclusion and recommendation on whether the above stated factors are the true determinants of electricity in the country.

4.5 RESEARCH TECHNIQUES

The study adopted both qualitative and quantitative methods which have been used as vehicles in the collection and analysis of data. Professionals have argued that both methods should be used together so as to ensure that satisfactory results are obtained. Other professional have though argued that such technical solutions underestimate the real politics of legitimacy which is often in most cases associated with the particular choice of any particular method. Despite the fact that a number of professionals have found quantitative method appealing, it should be noted that the right technique should depend on the objectives of the study which is being carried out.

Modell (2005) emphasises the importance of using qualitative and quantitative if the research topic needs to be explored, through combining case studies with survey-based research. This method enhances external validity (generalisation of research findings), internal validity (the credibility of the causal relationships between independent and dependent variables) and construct validity (refers to whether the operational definitions and measures of empirical research adequately reflect the theoretical concepts). In this way, since the nature and main objectives of this study were to examine and explore key determinants affecting the demand for electricity as well to examine the effect of determinants of electricity projects, combining qualitative method with quantitative method seems to be appropriate to fulfil this objectives.

It has also been seen that the collection of data through the use of questionnaires as being quantitative, observational and interviews are regarded as more qualitative. It is also important to note that interviews can also be structured and analysed as a quantitative manner. This happens in scenarios whereby the numerical data are collected on occasions when non-numeric answers are coded and characterised in a given specific numeric form. It is also possible to have open ended responses which will result in in-depth response studies of specific individual cases. Quantitative approaches are in most cases associated with a high level of objectivity while the qualitative approaches are in most cases associated with subjectivity (Neils, 2003).

Quantitative research is mostly concerned with the collection and analysis of data in specific numeric forms. It also put a lot of emphasis on large scale representative sets of data and in most cases is falsely viewed as a tool for gathering of necessary facts. It is an unarguable empirical type of research where all the data used are in form of numbers. The calculation which accompanies quantitative data makes it easier for the data to be represented in numerical form. The data is more convincing and simple to understand with an ease to interpret (Creswell, 2009).

The rationale behind adopting the questionnaire revolves around objectives and the accuracy of results. The data provided makes it possible for the calculations of means, variances, standard deviation among other important mathematical computations. According to Neils (2003) the method is also preferred to qualitative information since a researcher can compare a number of variables which are accompanied, reducing the possibilities of biases in the results.

The questionnaire assisted in probing the participants on some of the effects of stress and how it can be reduced. Quantitative research applies statistics and mathematical or computational techniques to empirically investigate social phenomena. Quantitative data is always represented in numerical form. The numerical data gives succinct information which helps in answering the clients' questions (Creswell, 2009). The advantages of Quantitative research include:

- It enhances greater accuracy, objectivity and validity of results;
- It gives a proof through the use of means that the data can be replicated in future research;
- It makes possible comparison and analysis of broader of subjects view; and
- It allows a researcher to have an opportunity to reduce personal biases.

The disadvantages include:

- The data collected in most cases is superficial;
- They are limited since they only give numerical description unlike detailed narrative information;
- In most cases data collection is usually carried out in unnatural and artificial environment (Weis and Fine, 2004); and
- Questions developed by the researcher are at times subjected to structural bias.

Despite the strengths of the quantitative approach, some researchers have argued that it gives limited information unlike the qualitative approach that gives more detailed information. The data is also regarded as giving artificial information which is not sufficient enough to arrive at a conclusion. The qualitative technique is the technique of gathering of data and is mainly focused on the real significance of various observations which are made in a specific study as opposed to the specific assigned raw numbers. It involves investigative methods which entails interviews and even detailed case studies. It is mainly used in the nursing profession and has gained an increased appreciation in the primary care setting (Creswell, 2009).

This kind of technique does not involve numerical information but more of theoretical technique. It involves the use of nominative and ordinal data. Nominative data often assigns a label to different categories and then the ordinal data besides the data, includes the rank. The adoption either depends mainly on the primary research questions or also on the use of statistical procedures to be used in the process of data analysis. For instance, the use of chi-square test is basically used for frequencies while ANOVA test (Analysis of variance) is used in the quantitative approach (Weis and Fine, 2004). Advantages of qualitative research include:

- The characteristic of this technique includes the purpose of the study, reality, viewpoint, values, focus, orientation, data, instrumentation, conditions and results (Weis and Fine, 2004);
- It has the strength when it comes to the covering of the experience of people and the discussion on why things happen the way they do, it is mainly focused on small groups and therefore less expensive as compared to quantitative technique which requires large data (Creswell, 2009);
- It helps in the producing of a more detailed and comprehensive information and therefore helps in coming up with a precise conclusion and recommendation on a study. According to Creswell (2009) it adopts a subjective approach/ information and also the participant observation to help

in the description of the context, or the specific setting of the variables which are being investigated and also the precise interactions between different variables in the context. It intends to seek the entire understanding of the situation.

The disadvantages of qualitative research include:

- Qualitative method techniques help in the collection of data concerning the specific select group of participants' feelings and thinking. It is impossible to use the information to make a general assumption about the group (Neils, 2003);
- Qualitative technique does not allow a method that conventionally helps in the collection of statistical data. It should though be noted that it is only a disadvantage if the research question also requires statistical data;
- The entire issue of subjectivity of the inquiry results in difficulties when it comes to the validity and reliability of various approaches and information;
- It is almost impossible to detect and prevent researcher induced bias which is common in a number of various research studies; and
- The new scope is mainly limited as result of its in-depth nature and also with the issues of the comprehensive process of gathering data in any study.

4.6 QUANTITATIVE METHODS USED IN THIS STUDY

To achieve the main aim for this study, the quantitative approach has been used to empirically investigate the dynamics of electricity demand in Libya for the period (1980-2010), by estimating the demand function for electricity using the method of least squares technique (OLS) (Ordinary Least Squares), and an attempt to answer the questions how and in what magnitude do price, income, population, appliance imports, and temperature affect the demand for electricity. How can we improve the accuracy of the said demand function in tracking realised demand. Does an empirical or econometric model of demand for electricity perform a better job in tracking electricity consumption in Libya? The study used the application software STATA to help when it comes to the analysis

4.6.1 Ordinary least-squares OLS regression

OLS regression is a generalised linear modelling technique that models a single response variable recorded on an interval scale. It makes use of sample data to estimate the true population relationship between two variables. It can be applied to single or multiple coded explanatory variables. It produces a line that minimises the sum of the squared vertical distances between the line of best fit and the observed data points. This means that the relationship between a continuous response variable (*Y*) and a continuous explanatory variable (*X*) can be represented using a line of best fit, where *Y* is predicted by *X*. This line is a straight line that fits the scatterplot best and can be represented in an equation as; $Y = \alpha + \beta x$ (see figure 4.1; Moutinho and Hutcheson, 2011)

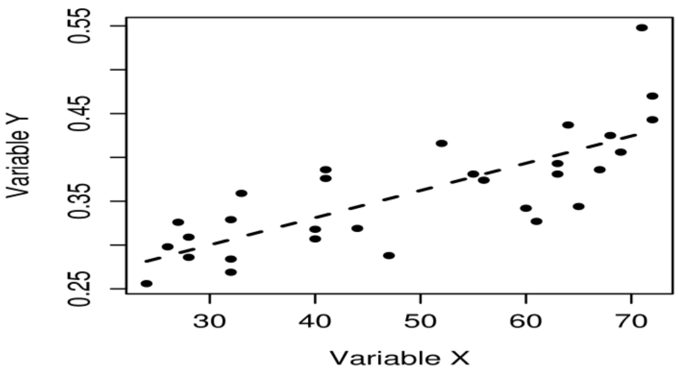


Figure 4.1: Least squares regression line

Source: Moutinho and Hutcheson, 2011.

The relationship between variables Y and X is described using the equation of the line of best fit with α indicating the value of Y when X is equal to zero (also known as the intercept) and β indicating the slope of the line (also known as the regression coefficient). The regression coefficient β describes the change in Y that is associated with a unit change in X. As can be seen from Figure 1, β only provides an indication of the average expected change (the observed data are scattered around the line), making it important to also interpret the confidence intervals for the estimate. In addition to the model parameters and confidence intervals for β, it is useful to also have an indication of how well the model fits the data. Model fit can be determined by comparing the observed scores of Y (the values of Y from the sample of data) with the expected values of Y (the values of Y predicted by the regression equation). The difference between these two values (the deviation, or residual as it is also called) provides an indication of how well the model predicts each data point. Adding up the deviances for all the data points after they have been squared (this basically removes negative deviations) provides a simple measure of the degree to which the data deviates from the model overall. The sum of all the squared residuals is known as the residual sum of squares (RSS) and provides a measure of model-fit for an OLS regression model.

A poorly fitting model will deviate markedly from the data and will consequently have a relatively large RSS, whereas a good-fitting model will not deviate markedly from the data and will consequently have a relatively small RSS (a perfectly fitting model will have an RSS equal to zero, as there will be no deviation between observed and expected values of Y). It is important to understand how the RSS statistic (or the deviance as it is also known; see Agresti, 1996) operates as it is used to determine the significance of individual and groups of variables in a regression model. A graphical illustration of the residuals for a simple regression model is provided in Figure 4.2.

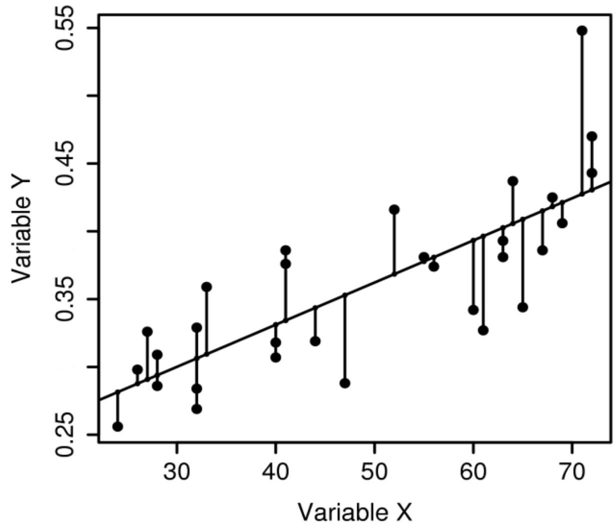


Figure 4.2: OLS regression model residuals

Source: Agresti, 1996.

In order to benefit from the well-behaved properties of an OLS estimate, a number of assumptions must be satisfied.

4.6.1.1 Assumptions made in OLS

There are seven assumptions necessary to produce unbiased estimators using OLS. Additional assumptions must be satisfied in order for the estimate to have other favourable qualities. The seven assumptions include (Burke, 2010):

- Model linear in parameters;
- Data of a random sample of the population with the residuals statistically independent and uncorrelated with each other;
- Independent variables not strongly collinear;
- Expected residuals value is always zero;

- Independent variables measured precisely such that errors in measurement are negligible;
- There is homogenous variance with the residuals having a constant variance i.e. (Tests for this include the Bruesch-Pagan test and Brown-Forsythe test); and
- Residuals are normally distributed.

4.6.1.2 Advantages and disadvantages of the OLS method

The OLS has a number of advantages and disadvantages. The advantages are that (Burke, 2010):

- If the expected value of the residuals is always zero, then the OLS estimator is unbiased;
- If the residuals have homogenous variance, then the OLS estimator has the minimum variance of all linear unbiased estimators as proposed by the Gauss- Markoff Theorem;
- If the residuals are normally distributed, then T and F tests can be used in inference. The bias and dispersion properties of the estimator do not depend on the normality of the residuals;
- If all the seven assumptions are satisfied, the OLS estimator has the most uniformly minimum variance of all unbiased estimators; and
- In a Y = AX +BZ model, A and B can be estimated by first regressing Y on X, then calculating the residuals and regressing those residuals on Z.

The disadvantages of OLS as a model are that (Burke, 2010):

- The assumptions required for OLS model are stringent such that if any of these assumptions are not met, then the OLS estimation procedure breaks down and the estimator no longer enjoys all of the discussed advantages;
- If the assumptions of homogenous variance in the residuals and normally distributed residuals do not hold, then the OLS estimator will be unbiased and consistent, though, it will be inefficient with the OLS giving incorrect estimates of the parameter standard errors;
- The third assumption - independent variables not strongly collinear – raises issues in practical application. Multi-collinearity in data causes problems since OLS estimation does not allow for correlation within residuals;
- In situations of heterogeneous variance, OLS estimates tend to be consistent and unbiased but inefficient. It underestimates the parameter standard errors resulting.

4.6.1.3 Multiple OLS regression

Multiple OLS regression is concerned with the relationship of a series of independent variables and dependent variable. Its objective is to minimise the sum of squared residuals. It allows for control of multiple factors that simultaneously affect the dependent variable. Its equation produces an m+1 dimensional surface presented as seen in equation 4-1 (Greene, 2003):

$$y_i = b_0 + b_1 x_{1,i} + b_2 x_{2,i} + \cdots + b_m x_{m,i} + \varepsilon_i \quad Equation\ 4-1$$

Where:

b_0 is the vertical intercept.

b_1 to b_m are slope coefficients with each coefficient *bj* for *j>0* representing the change in *yi* induced by a change in variable *xj,i* while holding all other variables constant. Using matrix notation, the multiple OLS equation is written as seen on equations 4-2 and 4-3:

$$\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} = \begin{bmatrix} 1 & x_{1,1} & x_{2,1} & \dots & x_{m,1} \\ 1 & x_{1,2} & x_{2,2} & \dots & x_{m,2} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 1 & x_{1,n} & x_{2,n} & \cdots & x_{m,n} \end{bmatrix} \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_m \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{bmatrix} \quad Equation\ 4-2$$

$$y \quad = \quad x \quad b \quad + \quad \varepsilon \quad Equation\ 4-3$$

Where:

(n x 1) vector *y* represents *n* observations *yi* for dependent variable,

(n x m+1) matrix x represents the n observations for each of the m independent variables xj, and a column vector of 1's

(m+1 x 1) vector *b* represents computed intercept *b0* and *m* slope terms *bj* for *j = 1* to *m* and the *(n X 1)* vector *ϵ* represents the *n* error and residual terms.

The regression coefficients b0 and b1 to bm in the coefficient vector is then solved as seen in equation 4-4:

$$\begin{bmatrix} n & \sum x_{1,i} & \sum x_{2,i} & \cdots & \sum x_{m,i} \\ \sum x_{1,i} & \sum x_{1,i}^2 & \sum x_{1,i}\, x_{2,1} & \cdots & \sum x_{1,i}\, x_{m,i} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ \sum x_{m,i} & \sum x_{m,i}x_{1,i} & \sum x_{m,i}x_{1,i} & \cdots & \sum x_{m,i}^2 \end{bmatrix}^{-1} \begin{bmatrix} \sum y_i \\ \sum x_{1,i}y_i \\ \vdots \\ \sum x_{m,i}y_i \end{bmatrix}$$

$$= \begin{bmatrix} b_1 \\ b_2 \\ \vdots \\ b_m \end{bmatrix} \quad Equation\ 4-4$$

Equation 4-1 is then solved for ε (i) which is then squared and summed to obtain equations 4-5 and 4-6 respectively:

$$\varepsilon_i{}^2 = \left(y_i - b_0 - b_1x_{1,i} - b_2x_{2,i} - \cdots - b_mx_{m,i}\right)^2 \quad Equation\ 4-5$$

$$\sum \varepsilon_i^2 = \sum \left(y_i - b_0 - b_1x_{1,i} - b_2x_{2,i} - \cdots - b_mx_{m,i}\right)^2 \quad Equation\ 4-6$$

Equation 4-6 is then rewritten as:

$$\sum \varepsilon_i^2 = \sum \left(y_i^2 + b_0 + b_1{}^2x^2{}_{1,i} - 2y_ia - 2y_ib_1x_{1,i} + 2ab_1x_{1,i}b_mx_{m,i} + b_2{}^2x^2{}_{2,i} - 2y_ib_2x_{2,i} + \cdots 2b_mx_{m,i}b_{m-1}x_{m-1,i}\right)^2 \quad Equation\ 4-7$$

Partial derivatives with respect to each of the m+1 bi coefficients and set them equal to zero to minimise the sum of error terms squared as seen in equations 4-8 and 4-9. Squared error terms are summed and minimised by setting each of the m+1partial derivatives with respect to coefficients equal to zero. Each equation from this set of m+1 equations representing one partial derivative, after slight rearrangement, is referred to as a normal equation which is then solved simultaneously for the coefficients (Greene, 2003).

$$\frac{\partial \sum \varepsilon_i^2}{\partial b_0} = 2\sum\left(b_0 - y_i + b_1 x_{1,i} + b_2 x_{2,i} + \cdots + b_m x_{m,i}\right) = 0 \quad Equation\ 4-8$$

$$\frac{\partial \sum \varepsilon_i^2}{\partial b_j} = 2\sum\left(b_j x_{j,i}^2 - y_i x_{j,i} + b_0 x_{j,i} + x_{j,i} b_1 x_{1,i} + \cdots + x_{1,i} b_m x_{m,i}\right)$$

$$= 0 \quad Equation\ 4-9$$

Upon determining the regression coefficients, then the significance of the results can be determined by basing the test of significance on the estimated standard error. The regression equation is rewritten as (Greene, 2003):

$$\varepsilon_t = y_t - a - b_1 x_{1,t} + b_2 x_{2,t} - \cdots - b_m x_{m,t} \quad Equation\ 4-10$$

The errors are computed for each unit time, then squared and summed to calculate the sum of squared residuals (sum of squared residuals $= \sum \varepsilon^2$. The test of significance on the standard error of the estimate is computed from $\sum \varepsilon^2$ as seen in equation 4-11 (Greene, 2003).

$$\sigma_\varepsilon^2 = \frac{SSE}{df} = \frac{\sum_{i=1}^{n} \varepsilon^2}{n - m - 1} = \frac{\sum_{i=1}^{n} (y_i - \hat{y}_i)^2}{n - m - 1} \quad Equation\ 4-11$$

The coefficient of determination (r-squared) is then used to measure goodness of fit. It measures the proportion of variability in the dependent variable that is explained by the variability in the independent variables. The multiple regression coefficient of determination (multiple r-squared) in some respects is determined by equation 4-12 as (Greene, 2003):

$$\rho_y^2 = 1 - \frac{\sum \varepsilon^2}{\sum (y_i - \bar{y})^2} 1 - \frac{\sigma_\varepsilon^2 . (n - m - 1)}{\sigma_\varepsilon^2 . (n - 1)} \quad Equation 4 - \ 12$$

The numerators in the fractions in equation 4-12 are the variance of residuals (times n-m-1) divided by the total variance of the dependent variable y (times n-1). Thus, the multiple regression coefficient of determination can be interpreted as 1 minus the proportion of total variance not explained by the regression (Greene, 2003).

F-statistic is used on multiple OLS regression to test its significance and whether the independent variable is independent of all explanatory variables. It tests the null hypothesis against its alternative such that (Greene, 2003):

H_0: $All\ the\ regression\ coefficients\ equal\ zero (b_1 = \ b_2 = \cdots = b_m = 0)$

H_A: $Regression\ coefficients\ do\ not\ all\ equal\ zero$

The calculated F-value is then compared to its relevant critical value such that if the calculated value exceeds its critical value, based on the number of sample observations and independent variables, the null hypothesis is rejected (Greene, 2003).

4.6.2 Cointegration and Granger Causality test

Cointegration holds that certain pairs of variables should be linked by a long run relationship. The framework of cointegration deals with regression models. The variables in time series tend to diverge as time increases because their unconditional variances are proportional to time, and the variables do not obey any sort of long run equilibrium relationship. The variables are, therefore, considered as cointegrated if they obey an equilibrium relationship in the long run, though they may diverge substantially from that equilibrium in the short run (Bagchi *et al*, 2004).

Alter and Syed (2011) define cointegration as an estimation technique that considers long run equilibrium parameters having unit root variables. It is applied in the determination of long run association between sets of variables and the causes of stability. Two or more variables are said to be cointegrated if in solitary they have stable long run linkages. It is a pre-test for avoiding spurious regression analysis. In cointegration analysis, the integration order of all variables should be same and greater than I (0), meaning that the series should be non-stationary at level form (Alter and Syed, 2011).

Some of the examples of cointegration include (Cavanagh *et al.*, 1995):

- A permanent income hypothesis that implies cointegration between income and expenditure;
- The money demand model that implies cointegration between nominal income, prices, interest rates and income;
- The growth theory model that implies cointegration between consumption, investment and income;
- Purchasing power parity that implies cointegration between exchange rate and prices;
- The fisher equation that implies cointegration between inflation and interest rates.

Cointegration in the m series can be written as a covariance-stationary component together with a smaller set of common trends. The cointegration purges the common trends from the resultant series. A cointegrating relationship between m series can be written as (Elliott, 1998); $v_t = y_t^{'}\eta - x_t^{'}\beta$. Rewriting this equation as a linear regression and use of OLS to estimate η results in:

$$y_t = X\beta + Y^*\eta^* + \nu$$

Where:

- Coefficient of y1 is arbitrarily normalised to unity.
- Y*= [$y_2 y_3 \ldots y_m$].
- Parameter vector η^* is equal to minus the free elements of the parameter vector η which is (m-1).

Two potential problems are realised in estimating cointegration vectors. They are (Elliot, 1998):

- Endogeneity whereby if the elements in the series are cointegrated then they are determined jointly; and
- Spurious regression resulting from regressing a variable on one or more variables. Spurious regressions are a problem when variables are near-integrated or integrated.

OLS can be used to obtain a consistent estimate of normal cointegration vector η. The strict unit-root assumption that cointegration typically relies upon is not easy to justify on theoretical grounds. Variables are highly persistent and, therefore, modelled as unit root processes. There is little reason to believe that these variables have an exact unit root, rather than a root close to unity. In fact, these variables show signs of mean reversion in long samples. Since unit-root tests have very limited power to differentiate between unit-root and close alternative, the pure unit-root assumption is based on convenience rather than strong empirical reasons. This has led to the belief in near-integrated processes to be a more appropriate way to describe many economic time series. The near-integrated process explicitly allows for a small deviation from the pure unit-root assumption (Cavanagh *et al*., 1995).

Granger Causality is a statistical hypothesis test for determining whether a one-time series is useful in forecasting another and also it is a method for testing for cointegration. Ordinarily, regressions reflect ‘mere’ correlations but Clive Granger who won a Nobel Prize in economics argued that a certain set of tests revealed something about causality. Granger Causality is a method developed to quantify the causal effect from time series observation in a non-experimental setting. It is explained as, X Granger causes Y if its past value can help to predict the future value of Y beyond what could have been done with the past value of Y only. The regression formulation of Granger Causality states that a variable X is the cause of another variable Y if the past values of X are helpful in predicting the future values of Y (Asimakopoulos *et al*., 2002).

It is based on the two principles, namely that cause (Asimakopoulos *et al*., 2002):

- Occurs prior to its effect;
- Makes unique changes on the effect. This means that the causal series contains unique information about the effect series not available otherwise.

Granger Causality has received positive attention in its simplicity, robustness, interpretability and scalability of extension to multivariate time series. Granger Causality has a number of disadvantages that include (Diks and Panchenko, 2006):

- Unobserved confounders where the causal order defines time order while the reverse is not always true;
- Instantaneous causation and structural Vector autoregression VAR models where instant causes cannot be detected with Granger Causality test, and the forward looking human behaviour creates cases in which their action causes a predictable event to happen before the event.

4.7 QUALITATIVE METHODS USED IN THIS STUDY

This part gives detailed information on the qualitative research methods design used by the researcher. It explains the target population of the study and the sampling procedure which is used in order to come up with the samples for the study. This part also highlights the data collection used to come up with the procedure.

4.7.1 Research design

Descriptive research design was used in this part of the study by collecting data, statistics and information on the area of research. According to Mugenda (2003), descriptive research is a process of collecting data in order to test a hypothesis or to answer questions concerning the current status of subjects under study. A descriptive research determines and reports the way things are. This method is preferred because it allows for an in-depth study of the case and is not limited to fact finding but can result in the formulation of knowledge and solutions to problems. Descriptive design is concerned with describing the character of a particular individual. This study investigated the opinion of employees (Coudouel, 2006 Pg 103).

4.7.2 Sample design

According to Kuul (1984) sampling is the process by which a relatively small number of individuals, objects or events are selected and analysed in order to find out something about the entire population from which the sample was selected. In this study, stratified random sampling was used to select respondents in the three population categories (managers, engineers and electrical professionals), this made all the respondents in the target population to have an equal and unbiased chance of participating in the study, and this was made possible since the sampling frame was available. The respondents were taken from the General Electric Company of Libya.

Sample is the number of units selected to participate in the survey. The study aimed to interview a census of 30. Simple random was applied to sample the study. A simple random sample is defined as a subset of participants picked from a large population. Purposive sampling was used to randomly pick the individuals for discussions. The samples that were selected to participate in the study were managers, technicians, engineers, technicians and other staff members.

To achieve a better understanding of one of the objectives of the study which was to examine the effect of internal and external determinants of electricity projects in Libya, a pilot study was carried out comprising 10 interviews in the General Electric Company of Libya (each lasting at least 1 hour), six of them conducted with senior managers and engineers, and four with electrical professionals who have experience of working in power plants; all practitioners have academic qualifications (two PhDs, four Masters, three Bachelor in management and engineering) and experience ranging between five and twenty years.

In order to validate the results of the study, this was achieved through workshops and group discussions with 20 participants in four groups, each group had five participants, these workshops included head managers, managers, technicians, engineers, technicians and other staff members in GECOL. These are people who had professional understanding of issues to do with electricity and are either involved in policy formulation or in the construction of the projects. The main purpose of this process was to ensure that the study and the proposed framework that was developed provided accurate results and performed a better job in tracking electricity consumption in Libya which helps in future decision-making. The validation took place after the verification process. This was achieved through the focus group.

4.7.3 Questionnaires

The questionnaire is a method of collecting secondary data. It is a list of questions relating to the field of enquiry and providing spaces for the answers to be filled by the respondents, there are various types of questionnaire which are a self-administered and an interviewer administered questionnaire as shown in the Figure 4.3 (Saunders *et al.*, 2003).

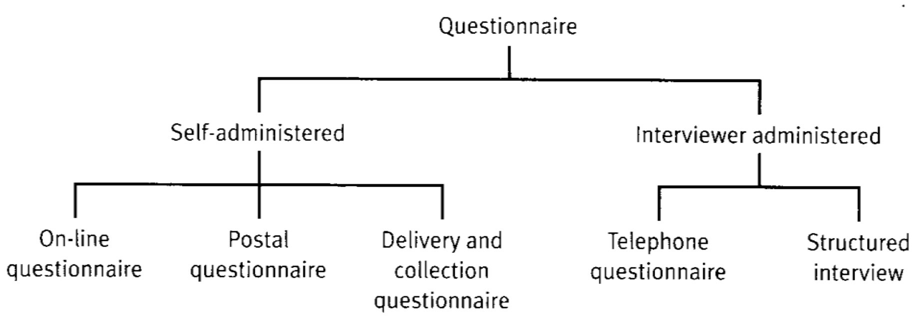


Figure 4.3: Types of questionnaire

Source: Saunders *et al.*, 2003

This study involved structured interviews this ensures that answers can be reliably aggregated. The method involves preparing a questionnaire which the researcher gave to respondents with a request for response. The questionnaire has both structured and unstructured questions. These are pre-determined questions and open-ended questions, whereby participants are served with a copy of the questionnaire and an information sheet explaining the purpose of the study, and set a date for the face-to-face interviews, in order to give them a chance to read and to take a decision to participate in the survey. Later in the interview we conducted the discussion, filled in and collected the questionnaire, the average time to complete the interviews was one hour. Thirteen interviews were conducted, ten interviews were adopted. The researcher asked questions and interpreted them effectively by listening carefully and not being influenced by pre-conceived ideas as well as being adaptive and flexible enough to respond to any situation that arose. All of the questionnaires, the information sheet and the participant consent form were also presented in the Arabic language. The survey was completed during the summer of 2013.

The questionnaire contained 18 questions (see Appendix K for more details), the researcher personally delivered and collected the questionnaires to and from the respondents; the same questions were put to each person and privacy of the information given is guaranteed. The main purpose of the questionnaire included:

- Consistent upsurge in the demand for electricity and electricity projects in Libya over the period (1980-2010);
- The main internal factors that cause an increase in the number of electricity projects under construction;

- The main external factors that cause an increase in the number of electricity projects under construction; and
- Investigate the attitudes and views of participants at the supply of electricity and its impact on the economy and social life.

4.7.4 Data analysis

According to Baily (1984), the data analysis procedure includes the process of packaging the collected information, putting in order, and structuring its main components in a way that the findings can be easily and effectively communicated. The data collected during the fieldwork in research methodology on the target groups using the questionnaire in Appendix (K), and mix of electricity projects were coded then edited first to check on the errors and omissions in the collected data. The data collected was then grouped based on similarity of response to ease accelerate understanding and lastly was tabulated to find numbers (see Appendix S) e.g. mean to interpret result of the study. Qualitative analysis involved the interpretation, description and the explanation of the tables and figure (Coudouel, 2006).

4.8 VERIFICATION AND VALIDATION

The concept of verification and validation are used to defend generalisations and specify the extent to which certainty has been achieved. However, the validity of measuring an attitude is important in order to check whether what is to be measured is actually measured. Validity is an important concept for attaining vigour in any research process. The verification strategies discussed in the context of this research place the responsibility for incorporating and maintaining reliability and validity of the research process squarely on the researcher as their responsibility. By verifying and validating the collected data, the research is expected to rigorously focus on attaining reliability by using verification strategies inherent within qualitative and quantitative research design (Kumar, 2005).

Validity determines whether the research study actually measures what it is supposed to measure or not. That is, whether the interpretation of the data is valid or not. This is achieved by comparing the data collection methods with those of previous research studies, and conducting preliminary investigations to find out which methods of data collection are likely to be most effective within the context of the research study (Yin, 2013). This part of research study is based on the actual study of a sample of electric company managers and, hence it can be assumed and inferred to be a representation of the opinion of electric company managers who were not part of the study. In addition, all precautions have been taken to ensure that the participants can engage in the discussion without prejudice. They have been chosen purposely so as to avoid any possible biases or the collection of inaccurate data.

Research verification and validation are important instruments in any research study. Rossman and Chance (2006), have noted three other validation instruments that are of importance in corroborating research. They include:

- Construct validity instrument. A construct is the parameter the research seeks to measure using the independent variable. The construct for this research study is the electricity demand function. The construct must be well-defined and be relevant to the research topic in the sense that it measures whatever is required. Construct validity must be protected at all times during the course of the research process;

- Internal validity instrument refers to how independent the research is from outside influence that could unduly influence its results and conclusions drawn. The research must isolate true scores while controlling them for differences. This must be protected at all times during the course of the research activity;
- Conclusion validity instrument refers to the conclusions drawn from the research. If the collected data is valid, but the conclusions drawn are invalid and not supported by the collected data, then the whole research process is considered flawed. The research invalidates data by making a conclusion error. This must be protected at all times during the course of the research activity.

4.8.1 Verification process in this study

Model verification is the determination of whether the implemented model corresponds to the conceptual model. To say that a model is verified is to say that its truth has been demonstrated, which implies its reliability as a basis for "decision-making" (Oreskes *et al.,* 2004). The purpose of the reliability analysis is to determine whether the collected data are trustworthy or not. Testing reliability involves measuring consistency in the data that is an assessment of the degree of consistency between multiple measurements of a variable (Simons, 2009). Reliability refers to whether a research study will produce the same results if conducted by another researcher at a different point in time. Validation aims at minimising the errors and biases in a study. This can be done by having the research instruments assessed by an individual who is independent of the study and has experience with research methodology (Blaxter *et al*., 2001; Oreskes *et al.,* 2004).

The model used in this study is an econometrics model, much econometrics research is based on mathematical modelling as the ordinary least squares (OLS), as previously mentioned that OLS is a linear modelling technique that models single response variable on an interval scale. In essence, it estimates the relationship between variables that can either be single or multiple coded explanatory variables. OLS on principle produces a line that minimises the sum of the squared vertical distances between the line of best fit and the observed data points such that the relationship between a continuous response variable and a continuous explanatory variable can be represented using a line of best fit, where the continuous response variable is predicted by the continuous explanatory variable (Moutinho and Hutcheson, 2011).

To verify that the Mathematical model does what it is intended to do, we should first of all read the documentation of the subroutine. Next they may estimate the mean, variance of the sampled variable and other necessary statistical tests, and compare those statistics with the theoretical values (Neukrug and Fawcett, 2014). In this study statistical tests were carried out to determine the probability of the relationship between variables being by chance (*this is presented in chapter 5*). In essence, they determine the probability of relationships existing and the strength of the relationship between variables. The probability level selected for the statistical tests applied in this research is 0.05 that translates to 5 per cent chance of making an error in conclusion.

4.8.2 Validation process in this study

The validation took place after the verification process; this was achieved through focus group discussions (FGD), where the purpose of FGD is to gain knowledge about a particular topic or need by interviewing a group of people directly affected by the issue. FGD are a systematic way of collecting the required research data by engaging people in integrative discussions whereby the researcher uses open questions to guide the discussion. Data is collected by analysing key themes emerging in the FGD. In addition, the participants are able to discuss their perception and interpretation with regards to the research topic which gives the opportunities for probing in order to get additional information (Gray, 2004). In this research, FGD was used as a research instrument to verify the findings of the study, whereby the results were presented and discussed with the managers and engineers who were not involved with the survey in the study. They have been chosen purposely so as to avoid any possible biases or the collection of inaccurate data.

The FGD has a list of questions that guide the discussion with the responses recorded and recurring themes identified. The order and wording of the questions can be changed depending on the direction of discussion (David and Sutton, 2004). According to Corbetta (2003), the order in which the questions are presented to the participants and the wording of the questions are left at the researcher's discretion. Within each topic, the researcher is free to conduct the conversation as they deem fit, to ask the questions they consider appropriate in the words they considers adequate, to give explanations and ask for clarification if the presented answers are not clear, to prompt for further elucidation if necessary, and to establish their own style of conversation (Corbetta, 2003).

In this study focus groups were conducted solely by the researcher, where 20 people were involved to do four of the focus groups, the purpose of the focus groups was to get views from participants about:

- The results of quantitative method which is used to estimate the determinants of the demand function;

- The results of qualitative method which is used to examine the effect of internal/external determinants of electricity projects in Libya; and
- The proposed framework for electricity organisations in Libya and discuss the implication of the proposed framework's implementation strategy in real life scenarios.

FGD give the researcher an opportunity to probe for views and opinions of the participants with the aim of exploring new paths which were not initially considered (Gray, 2004).The researcher conducting the FGD is freer and does not have to adhere to a detailed guide. Patton (2002) recommends that the researcher should explore, probe, and ask questions with the aim of elucidating and illuminating the particular subject.

The strengths of FGD are that the researcher can prompt and probe deeper into the given situation. Hence, the researcher is able to probe or ask more detailed questions of given situations without sticking to the FGD guide. In addition, the researcher can explain or rephrase the questions if participants are unclear about the questions (see Appendix L - Questions for focus groups). It is also necessary for the researcher to be aware of anticipated problems that could occur during the data collection process (Harvey, 2000). Such problems include:

- Response set bias: this refers to participants' personal characteristics that can influence their response to questions resulting in social desirability of the responses. The researcher should use appropriate techniques like explanation of the purpose of the research and assuring the participants that the information they will give will be confidential and not used to identify them thereby reducing the response set bias;

- Researcher bias: since the researcher will be conducting this study in the participants' natural setting, this could lead to distortion of the findings of this study. So as overcome this form of bias, the researcher should practise bracketing and flexibility. The researcher should also go back to the participants to verify and clarify their responses.

4.9 ETHICAL PROCEDURES

In conducting the study, the involvement of humans mandated that research ethics had to be followed. This study aimed at involving individuals from the General Electric Company of Libya (GECOL). The survey aimed at interviewing a census of 30 which included head managers, managers, technicians, engineers, technicians and other staff members. Therefore, the research participants had to be protected from any harm, in their involvement across the different phases of the research.

Anonymity was the first ethical principle that was adopted for practice in this study. Bulmer (2001) defined anonymity as the protection of research subject's identity. The protection of identity was in this case aimed at ensuring that they would not be victimized or discriminated against on any basis for providing information relating to the research issue. To protect the individual identities, this study selected the use of name initials. For instance, participants by the name Eden Johnson would go by the initials (EJ) when his data was being recorded for analysis purposes. This way, no one would directly determine the identity without consulting the researcher. The researcher on the other hand practiced a high level of trust and did not provide any details relating to the identity of the research subjects.

Additionally, the other major ethical practice that guided the current study was confidentiality. Based on the definition of Campbell (2006), confidentiality is the researcher's practice of concealing information collected from the respondents for research purposes only. The practice of confidentiality ensures that no data or information is revealed to parties that were not pertinent to the research. Commonly confidentiality is practise in research to protect the institutions involved and to gain their confidence (Case, 2000). In the current study, confidentiality was practised by making sure that information was for research purposes only. The results of the study were also printed and shared only with the research subjects and the institution involved, ensuring that it could not be replicated or abused. Data that was collected during data collection was also kept safe by using a password protected folder that was only accessible to the researcher. A few months after the completion of the study, the data will be destroyed by deleting the folder to ensure absolute safety.

In the data analysis procedures, the practice of integrity was adhered to in the current research. Elgesem (2002) also defined integrity in research ethics as a practice that ensures that the research uses a high level of objectivity in data analysis. The practice is applied in data analysis to avoid any level of researcher's bias and present reliable results. In the analysis of data from the research subjects, the researcher's views and opinions were kept aside and data presented as it was collected. To ensure that this was the case, the researcher reviewed the results over again and read through the participants responses to make sure that the real picture as per the respondents was presented.

The other major ethical procedure that guided the current study was intellectual property. As identified by Mavinic (2006), in research studies, the use of other scholars’ information is common. This is particularly in identifying the present gaps and developing the research objectives. Such use of original work should be guided by research ethics. Intellectual property was therefore identified as acknowledgement of other researchers' original works by using in-text citations and appropriate referencing (National Academy of Sciences, 2009). The current study was completed with appropriate citation across the text and a bibliography section at the end, which presented the cited work.

4.10 CHAPTER SUMMARY

This chapter provided the methodology and methods adopted to attain the objectives of the study. The theoretical framework is based on the economic theories methods of electricity demand perspective and the tracking ability of the demand function in other models, to explore the impact of economic and non-economic variables on electricity demand in Libyan. The data was collected for this purpose using a time series data and analysed by different statistical methods, namely: ordinary least-squares (OLS) regression, test for cointegration and Granger Causality. In addition, and in order to examine the effect of internal and external determinants of electricity projects in Libya, it was adopted and analysed by the questionnaire survey and the case study method.

In the following chapter which is chapter 5, estimation of the demand function is considered, while a description of the data gathered by the questionnaire survey is presented in chapter 6. The methodology chapter also explained how verification and validation was carried out. The next chapter provides the findings and results of the estimation of the demand function for exploring the determinants of electricity demand in Libya, and finding the response of the demand to changes in the determinants that have been included in the econometric model.

CHAPTER FIVE: ESTIMATION OF ELECTRICITY DEMAND FUNCTION

5.0 INTRODUCTION

In the last twenty years, the electricity power sector in most countries, both developed and developing, has been subject to restructuring. In the same way the interest of researchers, mainstream energy economists and policy makers has been rekindled in modelling the determinants of the energy demand function within the context of developing countries. Of importance is the need to obtain accurate estimates of electricity demand parameters. These figures are then used for the purpose of forecasting, demand management and also policy analysis. In modelling the electricity demand function, concentration has been centered on economic factors. The main economic factors in this case include electricity prices, real income and environmental factors like climatic condition and others include demographic factors like urbanisation and population which are often included as additional explanatory variables. In general, the dynamics of electricity demand and consumption are known to exhibit seasonality, mean reversion, high volatility and spikes. These special characteristics of electricity products, necessitate the use of special models for the estimation and forecasting of these variables (Chuku and Effiong, 2011). Hence, the motivation for this study was to examine the special characteristics of electricity demand in Libya.

Accurate forecast of electricity demand is very important for any country, as such it is important to establish how the price, income, population, temperature and appliance imports have affected the demand for electricity in Libya. This will help the government and the energy sector in Libya to establish, which areas need more investment in electric power to help spur economic development. Precise and robust estimation of electricity demand is also crucial due to the fact that overestimation of demand may lead to the government making unnecessarily large investments in electricity generation and transmission assets. This may burden the economy financially, due to the fact that Libya is a country which is developing and, as such, still struggling financially. Moreover, underestimation of electricity demand may lead to future shortages of electricity which may prove disastrous for the economy. For this reason, it is vital to devise an appropriate demand estimation model that can assist in providing accurate estimates of Libya's future demand for electricity.

Of the objectives of this study was to estimate the demand function for electric power in Libya using annual data for the period 1980-2010. This chapter describes the model used to estimate the demand function for electricity (based on the economic theory and previous studies), the method used to estimate, required statistical tests, Granger Causality, view results of the assessment and interpretation economically.

5.1 CHARACTERISATION OF THE MODEL USED

Access to specific variables of function of the demand for electricity in Libya, using the model where the quantity demanded of electricity is a dependent variable and the rest of the variables used in this study as independent variables. The function can be formulated as follows:

$$Q_t = f\,(P_t\,, Y_t\,, N_t\,, IM_t\,, D_t) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(5-1)}$$

Where:

Q_t = electricity demand (Giga watt-hours) at time t ;

P_t = real average electricity price at time t in Libyan Dinars;

Y_t = real income (expressed in real Gross Domestic Product GDP in Libyan Dinars);

N_t = number of population at time t;

IM_t = real value of imported electrical appliances at time t in Libyan Dinars: and

D_t = difference between the average maximum and minimum temperature.

5.2 ESTIMATION METHOD

This study estimates the demand function for electricity for the period 1980-2010 using the method of least squares technique (OLS) (Ordinary Least Squares) where all monetary values prices and income at constant prices of 1997 have been calculated (see Appendices A to J - The used data in the estimation of the function). The image of the function used in the study is the picture logarithmic , the form of the function logarithmic gives direct estimates of elasticities demand different, where can interpret the estimates values by the relative change in the quantity demanded of electricity resulting from change one unit in a independent variables, also the form of the function logarithmic reduces a problem instability contrast element random error, using logarithmic form to get the best compatibility for multiple regression equations.

For the purpose of analysing the demand for electric power in Libya, equation (5-1) is used which is formulated in the form of the natural logarithm, as follows:

$$\ln Q_t = a_{\circ} + a_1 \ln P_t + a_2 \ln Y_t + a_3 \ln N_t + a_4 \ln IM_t + a_5 \ln D_t + V_t \quad \text{.........} \quad (5\text{-}2)$$

The equation (5-2) assumes that the quantity demanded of electricity actual unresponsive or altered instantaneously directly in the same period of the changes that occur in the explanatory variables (independent variables), and thus did not take into account the period of time that passes before you begin the quantity demanded of electricity in response to a change in the explanatory variables, that is, they assume that any difference between the actual quantity and desired altered during the year, but the practical reality indicates otherwise, where the response occurs, but after a period of time so are resorting to adjustment mechanism partial expressed by Nerlove (1971) as follows:

$$Q_t - Q_{t-1} = \lambda \, [\, Q_t^x - Q_{t-1} \,] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5\text{-}3)$$

Taking the natural logarithm of the equation (5-3) is obtained;

$$\ln Q_t = \lambda \ \ln Q_t^x + (1\text{-}\lambda)\, Q_{t-1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots... \quad (5\text{-}4)$$

Where λ is adjustment factor of between 0 and 1, where 0 implies no adjustment and 1 implies instantaneous adjustment. Substituting equation (5-2) in the equation (5-4) is obtained;

$$\ln Q_t = \beta_\circ + \beta_1 \ln P_t + \beta_2 \ln Y_t + \beta_3 \ln N_t + \beta_4 \ln IM_t + \beta_5 \ln D_t + \beta_6 \ln Q_{t-1} + U_t \ .. \ (5\text{-}5)$$

Where

$\beta_\circ = \lambda \, a_\circ$ $\quad \beta_1 = \lambda \, a_1$ $\quad \beta_2 = \lambda \, a_2$ $\quad \beta_3 = \lambda \, a_3$ $\quad \beta_4 = \lambda \, a_4$

$\beta_5 = \lambda \, a_5$ $\quad \beta_6 = (1\text{-}\lambda)$ $\quad U_t = \lambda \, V_t$

The function of this form can be explained by economic results and their meaning easily, where the coefficients represent the elasticities of demand for electricity of the variables in the short run and the long run effects are derived by dividing the short run elasticities by the coefficient of adjustment λ. By reference to the general theory of demand and literature to the results of previous studies, coefficients expected to have different signals, the coefficients $\beta_\circ$ and β_1 are expected to have a negative sign, while the rest of coefficients are expected to appear with a positive sign.

5.3 ESTIMATION OF ELECTRICITY DEMAND FUNCTION

In order to estimate the demand for electricity, the following log linear demand function is conceptualised:

$$\ln Q_t = \beta_\circ + \beta_1 \ln P_t + \beta_2 \ln Y_t + \beta_3 \ln N_t + \beta_4 \ln IM_t + \beta_5 \ln D_t + \beta_6 \ln Q_{t-1} + U_t$$

Where:

β = Coefficients;

Q_t = electricity demand (Giga watt-hours) at time t ;

P_t = real average electricity price at time t in Libyan Dinars;

Y_t = real income (expressed in real Gross Domestic Product GDP in Libyan Dinars);

N_t = number of population at time t;

IM_t = real value of imported electrical appliances at time t in Libyan Dinars;

D_t = difference between the average maximum and minimum temperature;

Q_{t-1} = Qt lagged one year; and

U_t = the error term, with the usual assumptions.

This model is an autoregressive model since it includes the lagged values of electricity demand (dependent variable) as one of its explanatory variables. Moreover, it is a dynamic model as it portrays the time path of electricity demand in relation to its past values. The OLS method is used to estimate the parameter coefficients of the demand function defined in the previous equation. The OLS estimators are linear, unbiased, consistent, under certain conditions (regularity conditions) are asymptotically normally distributed and have minimum variance among the class of all linear unbiased estimators but assume homoscedasticity, non-correlation between the independent variables and no correlation between the error terms of different pairs of observations. Therefore, diagnostic tests are carried out before actual estimation in order to ensure that these OLS properties hold. The data used in the analysis is time series data, the data spans thirty one years covering the period from 1980 to 2010. STATA software was used to analyse the data.

5.3.1 Summary statistics

Based on table 5.1 which shows the summary of statistics, the mean shows the average value for each variable. The average value of electricity demand measured in Giga Watt-Hours is 13876.19, the average value of P_t is 0.0344484, the average value of real income in millions of Libyan dinars is 14968.68, the average number of people in thousands is 5140.365, the average real value of imported electrical appliances in millions of Libyan Dinars is 635.2097, and the average value of the difference in the maximum and minimum temperature is 13.17419. The standard deviation is a measure of dispersion, which indicates how the spread out the variable measures are (Field, 2006). For instance, the standard deviation for electricity demand is 7792.407 while that for the number of people is 1301.32. The standard deviation for electricity demand is the highest, 7792.407 indicating that there is significant variability in the consumption of electricity for the period 1980-2010. This is because the difference between the highest and lowest values of electricity demand, i.e the range, is enormous-(the minimum value is 3904 Giga Watt-Hours while the maximum value is 32558 Giga Watt-Hours).

Table 5.1: Summary statistics

STATS	Qt	Pt	Yt	Nt	IMt	Dt
MEAN	13876.19	.0344484	14968.68	5140.365	635.2097	13.17419
MEDIAN	11704	.0321	13110.9	5019.5	289.6	13.2
COUNT	32	31	31	31	31	31
RANGE	28654	.0313	17760.2	4593.2	2138.2	5.700001
MIN	3904	.0213	9015.2	3180.8	131.3	10.5
MAX	32558	.0526	26775.4	7774	2269.5	16.2
SD	7792.407	.0084164	5438.377	1301.32	604.4551	1.606646
SKEWNESS	.9076156	.4807092	2.680704	2.203589	1.241064	.318935
KURTOSIS	2.859384	2.227728	2.680704	2.203589	3.41508	2.385136

Source: Calculated by the researcher using STATA software

The median shows the value at the middle of the distribution, skewness indicates the degree of asymmetry of variable measures while kurtosis indicates the 'peakedness' of a normal distribution. From table 5.1 it is noted that the distributions of real income, real value of imported electrical appliances and difference in maximum and minimum temperature are highly positively skewed because their values of skewness are greater than 1.000, the distribution of electricity demand is moderately skewed since its value is between 0.5 and 1 while the distributions of average real price and the number of people are approximately symmetric since their values are between -0.5 and 0.5. Also all the distributions except the distribution of real value of imported electrical appliances are platykurtic. This is because their kurtosis values are less than 3. Platykurtic distributions have low and broad central peaks with short and thin tails. On the other hand, the distribution of the real value of imported electrical appliances is leptokurtic since its kurtosis value exceeds 3. Leptokurtic distributions have high and sharp central peaks with long and fatter tails.

5.3.2 Correlation

Multi-collinearity exists when there is perfect linear relationship or a high correlation between any two independent variables (Nikolić, 2012). The correlation results (Table 5.2) show that there is a high positive correlation of 0.9877 between the population component and the lagged electricity demand component. Also noted is a high correlation of 0.9360 between the real income component and the lagged electricity demand component. Graph 5.1 shows the relationship between the variables in the model, where there is a high positive correlation between, the population component and the lagged electricity demand component the real income component and the lagged electricity demand component and population component with the real income.

Table 5.2: Correlation matrix and variance inflation factor

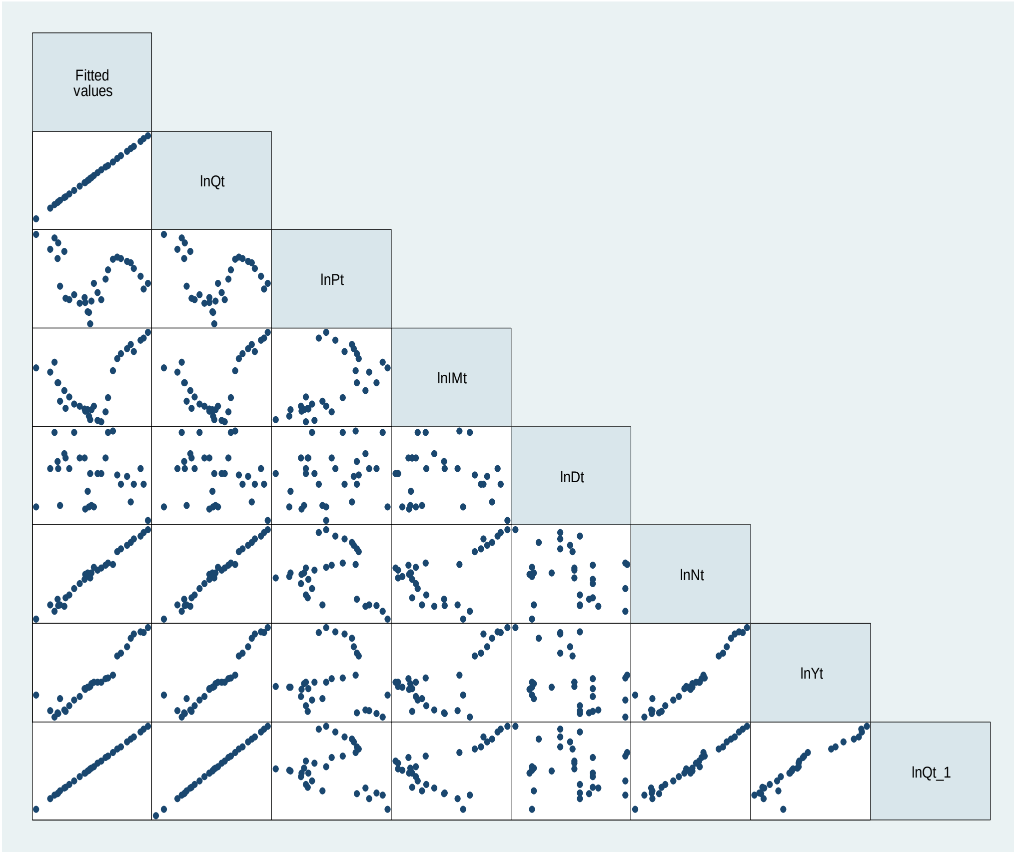
Correlation Matrix

	lnQt	lnPt	lnYt	lnNt	lnIMt	lnDt	lnQt_1
lnQt	1.000						
lnPt	-0.1440	1.000					
lnYt	0.9449	-0.0054	1.000				
lnNt	0.9908	-0.1752	0.9472	1.000			
lnIMt	0.4968	0.6127	0.6481	0.4767	1.000		
lnDt	-0.1906	0.2161	-0.3528	-0.2541	-0.1058	1.000	
lnQt_1	0.9916	-0.1885	0.9360	0.9877	0.4541	-0.2412	1.000

Variance Inflation Factor

Variable	VIF	1/VIF
lnNt	52.01	0.019229
lnQt_1	43.42	0.023030
lnYt	27.12	0.036877
lnIMt	5.58	0.179212
lnPt	3.18	0.314947
lnDt	1.61	0.619350

Source: Calculated by the researcher using STATA software



Graph 5.1: Relationship between the variables in the model
Source: STATA software

From the variance inflation factor output (*Table 5.2*), it is noted that the population component, lagged electricity demand component, and the real income component exhibit multicollinearity. This is because their VIF (variance inflation factor) values exceed 10 and their 1/VIF values are less than 0.10. In statistics, VIF quantifies the severity of multicollinearity in an OLS regression analysis. It provides an index that measures how much the variance (the square of the estimate's standard deviation) of an estimated regression coefficient is increased because of collinearity. The presence of multicollinearity usually does not affect the predictive power of the fitted model. Therefore, multicollinearity in this case of using the demand function for predictive purposes does not pose much of a challenge.

5.3.3 Model specification tests

Upon conducting the link-test, the results reveal that the coefficient of the squared residual is not significant since its p-value is greater than 0.05 and the confidence interval contains zero. This is indicative of a well specified model. Also, the Ramsey reset test for omitted variables (OV Test) reveals that there are no omitted variables since the p-value is greater than the normal threshold of 0.05 indicating that no additional variables are needed–the linear model has been correctly specified.

Table 5.3: Link test and OV test

LINK TEST

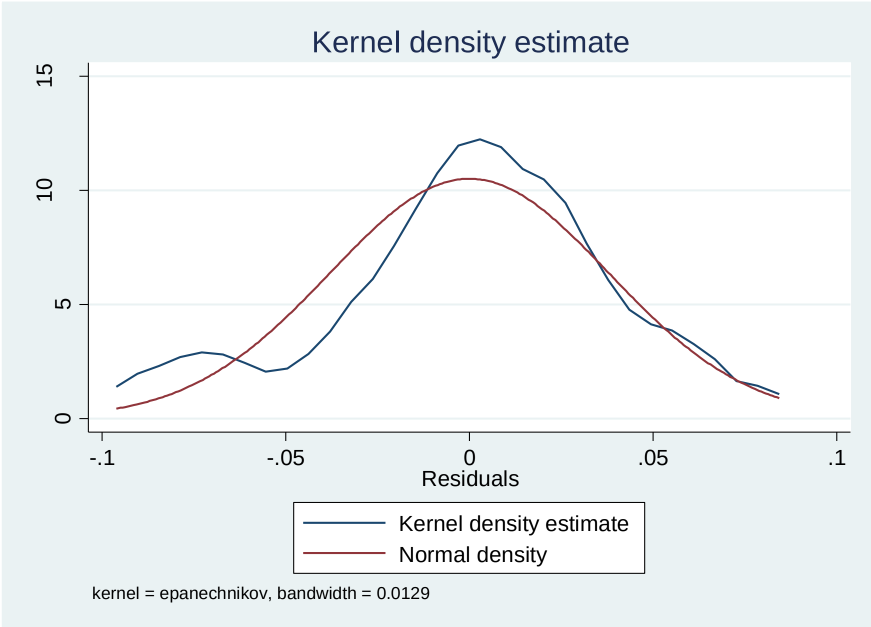
SQUARED RESIDUALS	STANDARD ERROR	|T|	P>|T|	95% CONFIDENCE INTERVAL
	0.296923	-0.87	0.393	-0.09 0.0351

OV TEST

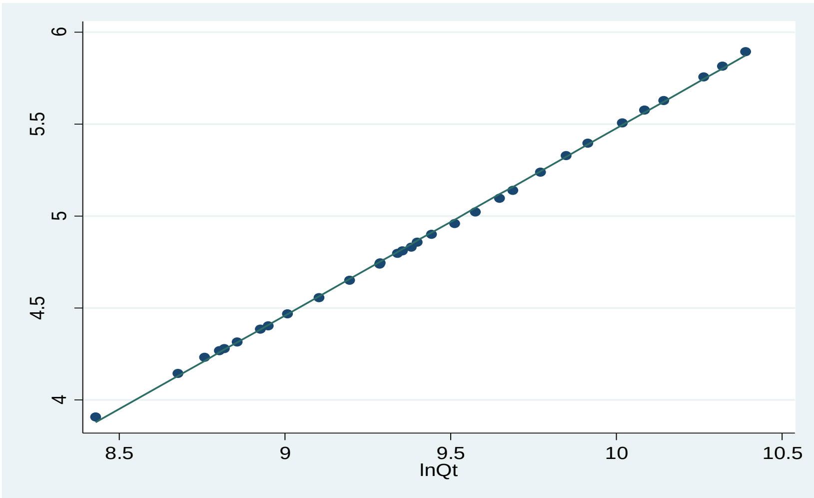
F (3, 23)	2.85
Prob>|F|	0.0599

Source: Calculated by the researcher using STATA software

The Density estimate graph reveals that the residuals are not perfectly normally distributed but more or less assume the classic ‘bell shape’ of normal distributions (Graph 5.2), the ‘bell shape’ of normal distributions reveal that the coefficient of the squared residual is not significant, which shows the validity of the use of the model in a practical sense. Also, upon conducting the augmented component plus residual plot for linearity (Graph 5.3), it is concluded that the distributions in the model assume linearity, which indicates that the model was determined with fewer errors in the estimation.



Graph 5.2: Density estimate
Source: STATA software



Graph 5.3: Augmented component plus residual plot for the dependent variable
Source: STATA software

Upon conducting the augmented Dickey Fuller test for non-stationarity, the results are presented in table 5.4; the variables concerned are stationary except temperature difference.

Table 5.4: Dickey Fuller test

VARIABLE	TEST STATISTIC	5% CRITICAL VALUE	INFERENCE
$\ln Q_t$	-0.987	-2.983	Stationary
$\ln P_t$	-2.087	-2.986	Stationary
$\ln IM_t$	0.037	-2.986	Stationary
$\ln D_t$	-4.016	-2.986	Non-stationary
$\ln Q_{t-1}$	4.538	-2.986	Stationary
$\ln Y_t$	0.596	-2.986	Stationary
$\ln N_t$	-0.454	-2.986	Stationary

Source: Calculated by the researcher using STATA software

Since all the test statistics except those that are greater than the interpolated Dickey Fuller 5 per cent critical value, the null hypothesis is rejected indicating that the variables concerned are stationary. In order to correct non-stationary, its first difference is used in its place. After this is done, it can be seen that all the variables are now stationary at 0.05 level of significance, as shown in table 5.5.

Table 5.5: Dickey Fuller test (after correcting the non-stationary)

VARIABLE	TEST STATISTIC	5% CRITICAL VALUE	INFERENCE
$\ln Q_t$	-0.987	-2.983	Stationary
$\ln P_t$	-2.087	-2.986	Stationary
$\ln IM_t$	0.037	-2.986	Stationary
$\ln D_{t\_1}$	-2.335	-2.989	Stationary
$\ln Q_{t-1}$	4.538	-2.986	Stationary
$\ln Y_t$	0.596	-2.986	Stationary
$\ln N_t$	-0.454	-2.986	Stationary

Source: Calculated by the researcher using STATA software

The model at this point is re-specified as follows:

$$\ln Q_t = \beta_\circ + \beta_1 \ln P_t + \beta_2 \ln Y_t + \beta_3 \ln N_t + \beta_4 \ln IM_t + \beta_5 \ln D_{t\_1} + \beta_6 \ln Q_{t-1} + U_t$$

Where

Q_t = electricity demand (Giga watt-hours) at time t

P_t = real average electricity price at time t in Libyan Dinars

Y_t = real income (expressed in real Gross Domestic Product GDP)

N_t = number of population at time t

IM_t = real value of imported electrical appliances at time t

D_{t_1} = temperature difference lagged one year

Q_{t-1} = Qt lagged one year

U_t = the error term, with the usual assumptions

5.3.4 Test for heteroscedasticity

Time series data refers to variable measures of observations being obtained for a specific defined time period (Mankiw, 2002). The data used is time series in nature because it consists of the variable measures of the electricity demand in Giga Watt-Hours, the real average price of electricity in Libyan dinars, real value of imported electrical appliances, and lagged values of the dependent variable for the years 1980-2010.

Time series data is normally characterised by autocorrelation i.e. the correlation between the error terms for different pairs of observations. This is because successive economic time series observations are likely to be interdependent. Heteroscedasticity which is the variation in the variances of the error terms for different observations is not normally expected in time series data but has to be tested so as to confirm if it is indeed absent. Some of the reasons why the variance of the errors may vary across the observations include; following the error-learning models, as people learn, their errors of behaviour become smaller over time, as incomes grow, people have more discretionary income and hence more scope for choice about their disposition of their income therefore, the variance is likely to increase with increase in income, skewness in the distribution of one or more regressors included in the model (skewness is expected in education and income) and the presence of outliers (observations that are very different in relation to other observations in the study).

Therefore, OLS estimation in the presence of heteroscedasticity will render the estimators as inefficient since they do not have minimum variance in the class of unbiased estimators (William, 2002). Due to this, correction of heteroscedasticity, if present is, necessary in order to obtain correct standard errors that would be used in hypotheses testing. The test used to detect heteroscedasticity is the Breusch Pagan heteroscedasticty test. The test results are as shown in Table 5.6

Table 5.6: The Breusch Pagan test

Breusch-Pagan test / Cook-Weisberg test for heteroscedasticity
Ho: Constant variance

Variables	LNP, TLNYT, LNNT, LNIMT , LNDT_1, LNQT_1
F(6 , 23)	3.13
PROB> F	0.6217

Source: Calculated by the researcher using STATA software

From the test results above, the null of homoscedasticity is not rejected hence implying the absence of heteroscedasticity.

5.3.5 Durbin H test for autocorrelation

Some of the causes of autocorrelation include inertia successive time series observations are likely to be interdependent, lags in the observations and non-stationarity of the error terms (Dowdy, 1983).

OLS in the presence of autocorrelation would render the estimators as inefficient since the standard errors obtained are spurious. These standard errors would yield wrong inferences if used in the t and f tests. The test employed to test for serial autocorrelation is the Durbin h test. This is because the model under consideration is an autoregressive dynamic model.

Table 5.7: Durbin h test

Durbin's alternative test for autocorrelation

lags (p)	chi2	df	Prob> chi2
1	0.101	1	0.7502

H0: no serial correlation

Source: Calculated by the researcher using STATA software

From the results above, the null of no serial autocorrelation is not rejected since the p-value exceeds 0.05. This implies that there is no serial autocorrelation.

5.4 REGRESSION RESULTS

The fitted model is:

$$\mathrm{lnQ_t} = -1.4 - 0.17\,\mathrm{lnP_t} + 0.16\,\mathrm{lnY_t} + 1.15\,\mathrm{lnN_t} + 0.07\,\mathrm{lnIM_t} + 0.06\,\mathrm{lnD_{t-1}} + 0.33\,\mathrm{lnQ_{t-1}} + \mathrm{U_t}$$

The Regression results as shown in Table 5.8

TABLE 5.8: REGRESSION RESULTS

Number of obs = 30 SSR (squared sum of squares for the regression) =27.6

F(6, 23) = 378.66 SSE (squared sum of errors) =0.74

Prob> F = 0.0000 MSR (Mean squared sum of residuals) =1.21=SSR/23

R^2 = R-squared = 0.99 MSE (Mean squared sum of errors)=0.003=SSE/23

$\bar{R}^2$ = Adj R-squared = 0.9874

Root MSE = .05656

lnQt	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
lnPt	- .1746204	.0789908	2.21	0.037	.0112154	.3380254
lnYt	.1592582	.2135137	0.75	0.463	-.2824286	.600945
lnNt	1.150636	.2629112	4.38	0.000	.606763	1.694509
lnIMt	.0738817	.0313977	-2.35	0.028	-.1388327	-.0089307
lnDt_1	.060454	.0964601	0.63	0.537	-.1390889	.2599969
lnQt_1	.3300334	8.79E-06	3.80	0.001	.0000152	.0000516
_cons	-1.417843	1.638683	-0.87	0.396	-4.807717	1.972031

Source: Calculated by the researcher using STATA software

From the results in table 5.8 there exists a negative relationship between the price component and the electricity demand. This is consistent with economic theory since the law of demand dictates such a relationship (Cohen, 2002). Also, the real value of imported electrical appliances, GDP, the number of people, the temperature difference and the lagged electricity demand are positively related to the dependent variable. An increase in the value of imports implies that the local demand is stimulated- hence the positive sign. Also, an increase in the population leads to an increase in the quantity demanded.

The adjusted coefficient of determination $\bar{R}^2$ shows that 99 per cent of the changes in electricity demand have been explained by changes in the independent variables, while 1 per cent of these changes are due to the effect of other variables that are not included in the model.

5.4.1 The (*t*-tests) for significance of the predictors

The test of significance of the predictors of price, the real value of imported electrical appliances, GDP, the population, the difference in temperature and the lagged electricity demand will show the strength of each of the predictors in determining the electricity demand. When conducting the individual tests, testing of hypothesis is used. The formulated hypotheses are:

$$H_\circ: \alpha_k = 0$$

$$H_1: \alpha_k \neq 0$$

Where:

k = 0, 1, 2, to 7 α = parameter coefficient.

The test statistic is:

$$T = \frac{\hat{\alpha}_k}{Se\ (\hat{\alpha}_k)}$$

Where:

k = 0, 1, 2, 3, to 7

Se ($\hat{\alpha}_k$) = OLS standard errors for the estimated parameters as shown in Table 5-8.

Since the sample size is greater than 30, the tabulated statistic is $(Z_{0.025}) = 1.96$

Also, if a parameter has a P-value of 0.000, then it is a significant predictor. If the P-value deviates from zero, then the parameter is not a significant predictor.

The 95 percent confidence interval estimator is also used to test for the significance of the predictors (Markowski, 1990). If zero is contained in the confidence interval, then the predictor is not significant. If zero is contained in the confidence interval, the predictor is significant.

The regressions results show that the test statistics for the predictors of GDP, real value of imported electrical appliances as well as the constant term are less than 1.96. Therefore, the null hypothesis is not rejected indicating that these predictors are statistically insignificant. On the other hand, the null hypothesis is rejected for the case of the predictors of electricity price, population, and the lagged electricity demand indicating that these predictors are statistically significant.

Also, the P>|t| values for the statistically significant are very close to 0.000 implying that the predictors are statistically significant while the values for the insignificant predictors deviate from zero. Alternatively, the 95 per cent confidence intervals for the statistically significant predictors do not contain zero while zero is contained in the confidence intervals for the statistically insignificant predictors.

5.4.2 The (F- test) for overall significance

The overall significance test is done using hypothesis testing, (Gujarati, 2009). The hypotheses concerned are:

$H_\circ$ = regression fit is not significant.

H_1 = regression fit is significant.

The test statistic is:

$F = \frac{SSR/6}{SSE/23}$ (where the degrees of freedom for the regression is 6 and for the error term is 23) while the tabulated F-statistic at 0.05 margin of error is F (6, 23, 0.05) = 2.53. The test statistic is F (6, 23) = 378.66. Considering that $|F| > F\ (6, 23)$ at 0.05 margin of error, the null hypothesis is rejected indicating that the regression fit is significant. Also, the P-value, (Prob >F) is 0.0000 indicating that the regression fit is significant (Table 5.8).

5.5 DETERMINATION OF THE ELASTICITIES OF DEMAND

The price elasticity of electricity demand measures the rate of responsiveness of the quantity demanded of electricity due to a unit percentage change in price (Arnold, 2008). This estimate is calculated as follows:

$$\frac{\frac{\delta Q}{Q} * 100}{\frac{\delta P}{P} * 100} = \frac{\delta Q/Q}{\delta P/P} = \frac{\delta Q}{\delta P} * \frac{P}{Q}$$

From the dataset, conversion of the variables into a natural logarithmic form that gives the impact (i.e. short run) elasticities can be estimated directly (Koutsoyiannis, 1992). From the formula:

$$\ln Q_t = -1.4 - 0.17 \ln P_t + 0.16 \ln Y_t + 1.15 \ln N_t + 0.07 \ln IM_t + 0.06 \ln D_{t-1} + 0.33 \ln Q_{t-1} + \cup_t$$

The price elasticity of demand is -0.17. This negative sign implies an inverse relationship exists between the quantity demanded and price (Böhm, 1987).

As the long run elasticity estimates are calculated: (Koutsoyiannis, 1992);

$$\frac{\beta}{1-\beta_6}$$

Where the β is the short run elasticity, and β_6 is the coefficient of the lagged dependent variable. In line with theory, it is expected that the short run elasticities will be smaller than the long run ones. In the short run, the price change affects demand slightly but in the long run a fairly large change in demand is more likely. Table 5.9 shows the short run (SR) and the long run (LR) elasticities of demand.

Table 5.9: Elasticities of demand

VARIABLE	SR	LR
$\ln P_t$	-0.17	-0.25
$\ln Y_t$	0.16	0.23
$\ln N_t$	1.15	1.71
$\ln IM_t$	0.07	0.10
$\ln D_{t-1}$	0.06	0.09
$\ln Q_{t-1}$	0.33	0.49

Source: Calculated by the researcher

Since the value of the price elasticity of demand of 0.17 and 0.25 are less than 1, it is inferred that at the given price, 1 per cent increase in price causes 0.17 per cent decrease in the quantity demanded in short run, and causes 0.25 per cent decrease in the quantity demanded in the long run.

It is also important to observe that the long run and short run income elasticity estimates are positive and less than 1. This indicates that the demand for electricity in Libya over the period 1980–2010 is both price- and income-inelastic. In other words, electric energy in Libya appears as a real necessity.

The decline in income elasticity can be attributed, to rising income of the Libyan economy, and making income elasticity low. This also demonstrates that the Libyan economy now consumes a high volume of electricity so that the high rate of income will not increase the consumption of electricity equally, and this result was reached on lower income elasticity consistent with the results of many scientific studies in different countries.

The values of coefficient demand for electricity in the previous period 0.33 and 0.49 in the short and long-term respectively mean that the actual demand for electricity takes a relatively short period in order to adjust to the desired level in the sense that 49 per cent of the actual demand for electricity adjusts to the desired level during the year.

5.6 COINTEGRATION AND GRANGER CAUSALITY TEST

Since the determination of the electricity demand does not necessarily imply causation, it is necessary to determine if the explanatory variables cause the electricity demand or vice-versa. When determining whether any of the explanatory variables causes electricity demand, the electricity demand is regressed against all its lagged values and the independent variables.

This regression constitutes the restricted model. The unrestricted model on the other hand includes all the lagged terms of electricity demand, the lagged terms of the independent variable under consideration and the other independent variables (Greene, 2002). The test statistic is:

$$f = \frac{(RSS_R - RSS_{UR})/m}{RSS_{UR}/n - k}$$

Where:

m= lagged terms of the variable claimed to have caused another variable;

k = number of estimated parameter coefficients in the unrestricted model; and

n= the sample size.

The tabulated statistic is F (m, n – k, 0.05). The length of the lag is determined from the Akaike information criterion. The null hypothesis is:

$$H_\circ: \alpha_i = 0.$$

The lagged m terms do not belong in the regression (The variable is not responsible for causation). Since the Granger Causality tests assume that there is no correlation between the error terms of the variables under consideration, the log-linear functional form of the model, which does not exhibit serial auto-correlation is used. Table 5-10 summarises the cointegration results

Key:

- $\ln Q_t$ is the logarithm of the electricity demand;
- $\ln P_t$ is the logarithm of relative electricity price;
- $\ln IM_t$ $\ln Y_t$ $\ln N_t$ are the logarithms of real value of imported electrical appliances, GDP and population respectively; and
- $\ln D_{t-1}$ is the logarithm of temperature difference lagged one year.

Table 5.10: Cointegration and Granger Causality test results

NOTION	TEST STATISTIC	TABULATED VALUE	NULL HYPOTHESIS	NATURE OF CAUSALITY
$\ln P_t \rightarrow \ln Q_t$	0.64778	3.07247	Fail to reject	no causation
$\ln IM_t \rightarrow \ln Q_t$	9.8891	3.07247	Reject	$\ln IM_t$ (Granger) causes $\ln Q_t$ The causality is bi-lateral
$\ln D_{t-1} \rightarrow \ln Q_t$	-0.2776	3.07247	Fail to reject	no causation
$\ln Q_t \rightarrow \ln P_t$	0.93384	3.07247	Fail to reject	no causation
$\ln Q_t \rightarrow \ln IM_t$	1.4664	3.07247	Fail to reject	no causation
$\ln Q_t \rightarrow \ln D_{t\_1}$	2.2513	3.07247	Fail to reject	no causation
$\ln Q_t \rightarrow \ln Y_t$	2.8613	3.07247	Fail to reject	no causation
$\ln Q_t \rightarrow \ln N_t$	0.2145	3.07247	Fail to reject	no causation
$\ln Y_t \rightarrow \ln Q_t$	4.2513	3.07247	Reject	$\ln Y_t$ (Granger) causes $\ln Q_t$ The causality is bi-lateral
$\ln N_t \rightarrow \ln Q_t$	8.2002	3.07247	Reject	$\ln N_t$ (Granger) causes $\ln Q_t$ The causality is bi-lateral

Source: Calculated by the researcher using STATA software

The Granger Causality tests reveal that the real value of imported electrical appliances, real income and the number of people causes electricity demand. Moreover, this causality is bi-lateral or feedback. This is because the set of all lagged independent variables and the electricity demand coefficients are statistically different from zero in both the restricted and unrestricted regressions.

5.7 DISCUSSION

The overall objective of the research was to estimate the demand function involving the values of electricity demand in Giga Watt-Hours, the average real price of electricity demand, the real value of the imported electrical appliances, GDP, population, the temperature difference and the lagged electricity demand in the natural logarithm states. Time series data covering the years between 1980 and 2010 is tested for multi-collinearity, stationarity, heteroscedasticity and autocorrelation before being used to estimate the model.

The variables, the average real price of electricity demand, the real value of the imported electrical appliances, GDP, population, the temperature difference and the lagged electricity demand, explain 99 per cent of the total variation in electricity demand. The regressions results show that price and quantity demanded are inversely related while the real value of imported electrical appliances, the population, GDP and the electricity demand are positively related. These results are consistent with economic theory and the a priori expectations.

This is because according to the law of demand the price of a certain commodity is always negatively related to the quantity demanded ceteris paribus for the case of normal goods. Also, an increase in the level of imports stimulates local demand hence the positive relationship. When the population increases, the quantity demanded will also increase so as to satisfy the increasing number of people.

The price elasticity of demand and income elasticity of demand are inelastic, that means that the Libyan economy now consumes a high amount of electricity and the electric energy in Libya is real necessity. Notes that the price elasticity of demand and income elasticity of demand in the long run are greater than elasticities in the short run, this means that these variables have a significant impact on long-term. Thus it can be explained that the increase in income leads to increased demand for electricity in the long-term through the ability of individuals and industrial and service institutions to acquire more electrical appliances that have a direct impact on the demand for electricity. This interpretation is confirmed from the Granger Causality results, it was established that there exists a bilateral causality from real values of imported electrical appliances to electricity demand and from population to electricity demand.

The predictors of the electricity price and the lagged electricity demand satisfy all the significance tests while the others are less. Therefore, it can be seen that according to this model, the average price of electricity and the population are significant determinants of electricity demand while the others are less. Moreover, it implies that regardless of the temperature difference between the maximum and minimum, individuals are likely to demand electricity when the prices are low (Lomax, 2007).

5.8 CHAPTER SUMMARY

This chapter discussed the process of estimation of electricity demand function in Libya for the period 1980-2010 using the method of least squares technique (OLS) , and provided an answer to the question how and in what magnitude do price, income, population, appliance imports, and temperature affect the demand for electricity. The results showed that the variables the average real price of electricity demand, the real value of the imported electrical appliances, GDP, population, the temperature difference and the lagged electricity demand explain 99 per cent of the total variation in electricity demand. The price elasticity of demand and income elasticity of demand are inelastic in both short run and long run that means that the Libyan economy now consumes a high amount of electricity and the electric energy in Libya is a real necessity.

The demand elasticities show that the magnitude of determinants affects the demand for electricity. When the price increases by 1 per cent it causes 0.17 per cent decrease in the quantity demanded in short run, and causes 0.25 per cent decrease in the quantity demanded in long run. Increasing income by 1 per cent causes 0.16 per cent and 0.23 per cent increase in the quantity demanded in the short run and long run, respectively. Increasing population by 1 per cent causes 1.15 per cent and 1.71 per cent increase in the quantity demanded in the short run and long run respectively. Increasing appliance imports by 1 per cent causes 0.07 per cent and 0.10 per cent increase in the quantity demanded in the short run and long run respectively. Increasing temperature by 1 per cent causes 0.06 per cent and 0.09 per cent increase in the quantity demanded in the short run and long run respectively.

This chapter also provided to answer the following questions:

- How can we improve the accuracy of the said demand function in tracking realised demand?; and

- Does an empirical or econometric model of demand for electricity perform a better job in tracking electricity consumption in Libya?

The answers were through statistical tests that were made to the model used. According to the model used in this study the average price of electricity and the population are significant determinants of electricity demand while the others are less. Also this chapter provided the answer to the question, how can we compare the tracking ability of the demand function for electricity in Libya vis-à-vis other models that purport to track the consumption of electricity in Libya? The answer was through cointegration and Granger Causality test. The following chapter attempts to answer the question, what is the effect of internal and external determinants of electricity projects in Libya, using the tools of the qualitative method through the use of interviews and questionnaires.

CHAPTER SIX: INTERNAL AND EXTERNAL DETERMINANTS OF ELECTRICITY PROJECTS IN LIBYA

6.0 INTRODUCTION

The examination of the estimation of electricity demand function in chapter (5) showed that the average price of electricity and the population are significant determinants of electricity demand during the period from 1980 to 2010, then followed by the income and the imported electrical appliances according to the level of importance. In addition, the Granger Causality results established that there exists a bilateral causality from real values of imported electrical appliances to electricity demand and from population to electricity demand.

This chapter looks at the supply side of electricity in an attempt to explore the internal and external determinants of electricity projects and the impact of these determinants on electricity projects in Libya during the period from 1980 to 2010. In order to carry out the research for this objective to investigate these determinants of electricity projects, this researcher conducted surveys in the General Electric Company of Libya GECOL. A total of ten interviews were carried out during the summer of 2013 with the head managers, managers, technicians, engineers, technicians (each interview lasting at least 1 hour), six of them were conducted with senior managers and engineers, and four with electrical professionals who have experience of working in power plants. In addition to the interviews, the secondary data was gathered using the company's documents and the researcher's direct observations. Most of the documents were examined during the course of the field research. Copies of these documents were obtained, including annual reports of GECOL for the years from 2003 to 2010.

The questionnaire was designed to have five sections each with a specific function to gather information about a particular area of the research; in each section there are a number of questions, each section ends by asking questions about the personal opinion of the participant (see Appendix K Questionnaire for more details). The first section was to create a profile of participants asking about their job role, they were asked about their academic qualifications, experience in this field, functional specialisation in the company and the period that he/she has worked within this company. Then in the second section, questions one, two, three, four, five, six and seven were asked to investigate in problem of the electricity projects and also to discover if there are enough number of electricity projects in Libya to face the consistent upsurge in the demand for electricity in Libya over the period 1980-2010.

In the third section of the questionnaire participants were asked questions eight and nine specifically relating to internal factors that cause an increase in the number of electricity projects under construction. In the fourth section the question ten and eleven were about external factors that cause an increase in the number of electricity projects under construction. In the fifth section the rest of the questions were to investigate the attitudes and views of participants about the supply of electricity and its impact on the economy and social life (see Appendix-attach questionnaire).

Among the objectives of the study was to investigate effect of internal and external determinants affecting the electricity projects in Libya during the period 1980-2010. Specific objectives of this chapter:

- To find out the effect of electricity demand on electricity projects in Libya;
- To investigate how political effects impact electricity projects in Libya;

- To analyse the effect of electricity tariff on electricity projects in Libya;
- To find out how inflation affects electricity projects in Libya;
- To analyse how oil prices affect electricity projects in Libya;
- To find out the effect of development in other infrastructure on electricity projects in Libya.

This chapter is structured as follows. Section one presents the background of the electricity projects in Libya. Section two explains the objectives of this chapter. Section three and four explore and analyse the internal and external determinants of electricity projects in Libya. Section five discusses the findings. Finally, section six summarises the chapter.

6.1 THE ELECTRICITY PROJECTS IN LIBYA

The recent past saw the initiation of various electricity projects in the country. Currently, the supply in the country is not enough to meet the demand for various activities that go on in the country (as majority of participants stated). The demand is high as compared to the number of people that are in need of the projects. The increased investments require increased supply which the economy cannot sustain. This has resulted in the government being forced to initiate various projects that can meet the demand

To investigate problem statement of the electricity projects in Libya, the participants were asked to indicate if the electricity projects have a problem in the development and construction of new projects. Participants acknowledged that there are problems facing the energy sector in Libya. The majority of the participants noted that Libya has a large land area and this needs a lot of money for the construction of new power projects or even maintenance and development of existing projects. Libya extends over 1,759,540 square kilometres (700,000 sq mi), making it the seventeenth largest nation in the world by size, and the fourth largest country in Africa by area (World Atlas, 2014).

The population of Libya is 7.774 million people, small compared to an area of the country, the problem is that people live in scattered cities and villages (Central Bank of Libya, 2014). In most of the world the problem facing the electrification of low population areas or of regions far away from the existing electric networks is a financial one. It is so expensive to extend high voltage lines through desert to provide electricity for a few hundred inhabitants. In many low population countries electricity is only available in the cities and no electric network is used to power their rural areas. The Libyan national plans to electrify rural areas consist of electrifying scattered houses, villages, and water pumping. The Photovoltaics PV supply systems for ten villages were introduced as a project to electrify remote areas (Saleh Ibrahim *et al.*, 2006).

The production and supply of electricity in the recent past has been a major concern to the company in the country. A majority of participants stated that the problem can only be solved if the government manages to construct the proposed power units in the country. Foreign companies that were working on these projects should also be requested to come back to Libya. Libya is currently working on producing a capacity of about 4.6-4.7 Giga watts. The peak load of production is around 3.3 GW. Most of the electricity stations are fired by oil though a number have been converted to the natural gas. The demand for power is growing annually at around 6-8 per cent and the statistic reached 5.5 GW in 2010 and in 2020 it is expected to reach 10.2GW (Parker, 2011).

There have been planned projects other than the gas-fired facilities, however, the majority of them seem to have stalled. For instance, in February 1995, Siemens secured a letter of intent to construct a gas-fired power plant (with a 450-megawatt MW capacity) in Sebha, which is located 300 miles south of Tripoli. Initially, the plant was to be completed in 18 months but this did not happen. Other plans to use the natural gas include the construction of an 800-MW plant in Zuwara, a 1,400-MW power plant between Benghazi and Tripoli, and a combined desalination and power complex in Sirte. The favoured bidder for projects was France's Alstom; other bidders included Germany's Deutsche Babcock and Siemens, and Switzerland's ABB (USA, 2007). In 2004, during the summer, the nation faced widespread blackouts, the reason given was that the existing power plants could not meet the existing demand in the economy. In order to reduce the instances of blackouts in the economy and to meet the cost of the up surging demand, GECOL which is a state owned company spent $3.5 billion in 2010. The amount was intended to be used in the construction of eight new steam cycle power plants. The construction though started in 2004, was derailed due to lack of finances (Parker, 2011).

During the interviews with the participants, there was an assessment of the status quo, it is considered that the problem confronting development of the electricity projects in Libya has three components. The first is the national significance of the projects as a physical resource. The second is the conflict arising politically from within. The third is the lack of consideration given to the specific resource management issues associated with the projects within the government plans and policy statements.

To investigate if the government of Libya has carried out enough electricity projects to meet the demand, the participants were asked to indicate if the government of Libya has adopted regular mechanisms to deal with the consistent upsurge in the demand. Normally when demand increases, there should be a proportionate increase in the supply of electricity in the country. On the contrary, this has not been the case in Libya, as the participants stated. The authorities have not been in a position to offer this. In the unlikely scenario that the demand for electricity stagnates, then the government will not be in a position to need more projects to supply electricity in the country.

The current projects are mainly being done to ensure that they meet the need of the populace in the economy. Being one of the major drivers for an economy to grow, it was axiomatic during the interviews for the participants to allude that the government has no option but to initiate more projects to deal with the issue of shortage. In equilibrium conditions, (ceteris paribus) there should be an equivalent quantity of demand and supply. The balancing act is only possible when the demand increases at a proportion similar to that of the supply. The construction of projects has been mainly influenced by the need to have more electricity supplied to meet the demand in the country.

A majority of participants stated that before the revolution in the country in 2011, there were five main projects which were going on in different regions of Libya and these were Misrata, North Benghazi, Obari, West Tripoli and the Gulf Site. The majority of work has been done in three out of the five projects, though minimal work has been done in Tripoli and Obari since the revolution started. Serious operations have since not re-started given the fact that the myriad companies that were working on them were still weighing the security situation in the country, as the participants stated. The companies include Daewoo, Siemens and Gama Electronics. Libya also intends to make use of its vast renewable energy potential. Research has shown that the country has some of the largest swathes of desert (the Sahara) and also it has the highest level of solar radiation in the whole world.

The country also has a very high average speed of wind in a number of locations in the country therefore making it a good destination for various wind energy firms. The Libyan authorities have identified the potential in the country and intend to ensure that 10 per cent of electricity generation in the country will be purely covered by renewable energy. Government records show that improvements in the electricity use in the country can ensure the reduction by 2160 MW by the year 2020 (Berndt, 1991).

Aside from being very poorly managed, Libya's electricity sector is largely unsustainable. Electricity is generated mainly by burning natural gas, a finite and environmentally harmful source. To date, there has been little reliable research conducted in the field; at best, some estimates predict 30 years of oil production left, but the true reserves are unknown (Coudouel, 2006). In planning for Libya's future, at some point there needs to be a managed shift away from oil fields to more sustainable options, but there has so far been little or no debate on the practical matters of rebuilding the country. No visible planning of a renewable energy sector has taken place, and references in Libyan media and discussion are simplistic, it is proudly touted that Libya has the financial resources to become a world-leader in the field, but no further depth is added. Despite the current impotence of the transitional government, these issues must be brought to the fore and debated, so that candidates for elections are compelled to consider them and develop strategies in order to win votes.

6.2 INTERNAL DETERMINANTS OF ELECTRICITY PROJECTS IN LIBYA

6.2.1 Electricity demand effect on Libya's electricity projects

The construction of electricity projects depends on the continuous demand for electricity in the country (Halvorsen, 1993). From the verification results, an investigation of the internal determinants of electricity projects in Libya showed that the most effective factor was the demand for electricity, participants agreed that the number of projects which are being initiated in Libya is mainly informed by the increased demand which has been recorded in the country. Statistics indicate that the demand for electricity in Libya has been on the rise for more than a decade (GECOL, Annual Report). Also, a majority of participants agreed that the population factor is the main determinant of demand, as a senior manager stated:

> "*The population, the households, size of households and urbanisation are increasing, which leads to a need to have a higher supply*"

Population is a cause, though an important causal variable, since population trends are applied when it comes to the projection on the number of persons who are staying in a country and might be interested in the electricity in the country. These groups of people will influence the number of projects constructed in the country. In Libya both the size and the number of the households plays a very important role with regards to influencing the electricity demand in the country. The household numbers on a higher note affects the total number of the residential customers who are in a position to purchase electricity and also the variations on the size of the households will affect the level and size of usage of electricity. When the numbers of customers are high then it means that the demand for the electricity will be high. A high number of the residents will be in a position to demand the electricity. This will lead to an upsurge on the pressure on the supply of electricity and therefore more projects. (Berndt, 1991)

Population level has a direct influence on electricity production and consumption. It has been observed that population level affects water consumption especially by tapping water for irrigation and for home consumption: as the senior engineer stated:

> *"The amount of water usage is often of great concern for electricity generating systems as populations increase and droughts become a concern".*

Libya's population of roughly 5,115,450 (est. July 2000) has seen a yearly growth rate of 3.5 per cent since 1975, when it was 2,400,999. With a forecasted yearly growth rate of 2.1 per cent, the population will reach 7,600,000 in 2015. In 2000, the birth and death rates were 27.68 births per 1,000 population, and 3.51 deaths per 1,000 populations, respectively (Encyclopedia of the Nations, 2014).

The residential demand for electricity in the country is presumed to be mainly resulting from various exercises of choice whereby the consumer maximises the welfare which is subjected to the budget constraint. The demand for electricity by the consumer is believed to be a function of price complements like natural gas and the consumer choice. It is worth noting that electricity does not directly convey any benefit to the consumer. According to Berndt (1991) the consumers in most cases instead will gain from the services of the appliances which mainly require electricity. The services include cooking, refrigeration, air conditioning, drying and washing clothes among other numerous services. For commercial and other industrial activities electricity is a major factor of production which is inclusive of the inputs.

Halvorsen (1993) suggests that the presented demand for electricity is believed to result from a number of decisions which are taken by the producer when it comes to the maximisation of profits. For the producer who is interested in maximising profit, the price of any related product which includes the electricity is mainly driven by the prices, level of output and the price of other related products. Their demand for electricity is also influenced by other factors which include water and weather condition in a country. The existing demand for electricity projects in the country depends on the number of consumers who are in need of the electricity, the level and type of goods which are being produced in the country.

6.2.2 The effects of political factors on Libya's electricity projects

The government of any state has a political impact on the different sectors of the state, as well as on international relations. Internal conflicts or external conflicts with other countries can deny access to development funds and these could affect electricity development projects (Momo, 2010). From the verification results a majority of the participants affirmed that the internal and external Libyan practices and policies played a role in electricity projects in Libya, external political conflicts have resulted in no development because parts of the country have no supply of electricity and especially in the rural areas. Lack of electricity in these rural areas has resulted in lack of improvement, making the country lag behind, economically, as a senior manager stated:

> *"Internal Libyan practices and policies were affecting development projects in Libya, particularly in the awarding of contracts to foreign companies for the*

construction of electricity generation plants. Policies and procedures of Gaddafi's rule were responsible for the unwillingness of foreign investors to construct more electricity projects in Libya over the period 1980-2010"

Radicalism was further extended to the economy by the president, with the Libyan leader adopting awkward ideological thinking that is not conducive to faster economic growth, ideas such as socialism, Arab nationalism and populism. While executing these ideologies, Gaddafi outlawed the ownership of private property and demanded the elimination of private savings. Such radical ideological reforms had disastrous effects on the construction of electricity projects by private firms (Zoubir, 1999).

The U.S and UN unilateral sanctions are an example of one of the factors resulting from the practices and policies of Libya. During this period, investors shunned away from investing into Libya's oil resources. As suggested by participants, during this time, electricity projects that were being constructed by foreign countries had to be stopped. The electricity projects could only be completed after the UN sanctions on Libya had been removed in 1999. The Libyan economy and other electric projects weakened at about the same time president Reagan's administration imposed trade sanctions on Libya (O'Sullivan, 2003).

In addition, major environmental issues and international environmental agreements have hampered Libya's electricity projects (USA, 2007). The major environmental issues include limited natural fresh water resources, desertification, and the Great Manmade River Project. The manmade river project will be the biggest water development system in the universe and it is being constructed to convey water from the large Sahara aquifers to the coastal cities. The major international environmental agreements include Conventions on Desertification, Marine Dumping, Nuclear Test

Ban and Ozone Layer Protection. Libya has signed and ratified these agreements. Agreements signed but not ratified by Libya include Biodiversity, Climate Change and Law of the Sea (USA, 2007).

6.2.3 Electricity tariff effect on Libya's electricity projects

From the verification results, a majority of participants stated that the electricity tariff does not have a role in attracting the investment in new electricity projects. The Director of the Consumer Department suggested that:

> *"Prices of electricity remained stationary for long periods from 1980 to 1995, then the prices changed in accordance with the Resolution No. 93 for the year 1995 and these prices are still fixed so far for various sectors".*

This means that real electricity prices tend to decline over time (see Appendix I). As the senior engineer noted:

> *"We are working as a monopoly company supported and protected by the state; the company was established to achieve social and national objectives, such as creating job opportunities for Libyan people and providing the domestic market with goods and services, while profitability was not a priority".*

The General Electric Company of Libya and its branches are owned by the state, undertake the implementation of projects in the operation and maintenance of electrical networks, energy production plants, distribution stations and conversion, power transmission lines and distribution, electrical control centres, management operation and maintenance of water desalination plants (General Electric Company, Annual Report, 2014).

6.3 EXTERNAL DETERMINANTS OF ELECTRICITY PROJECTS IN LIBYA

6.3.1 Recession

A recession is a business cycle reduction, which is a common deceleration in economic movement (Willis, 2011). In case of a recession potential investors will be discouraged from investing in an economy. This would mean that electricity projects are not carried out. Macroeconomic signs such as GDP, employment, investment spending, capacity utilisation, household income, production profits, and inflation fall, whereas bankruptcies and the unemployment rate increase. Recessions normally occur when there is a prevalent fall in spending (an adverse demand shock). Recession can be triggered by different events, such as a financial crisis, an external trade shock, an unfavourable supply shock or the bursting of an economic bubble. Governments use expansionary macroeconomic policies, such as increasing money supply, increasing government spending and decreasing taxation during a recession (Willis, 2011).

Several factors explain the recent trends in investment especially in electricity projects. Private-sector firms were deeply affected by the Asian and subsequent Latin American financial crises. The Enron collapse and its aftershocks also featured prominently in influencing American and European-based firms to reduce risk exposure in emerging and developing-country markets and refocus on core activities at home (Coudouel, 2006). Furthermore, DFIs began to reconsider their position on restricted infrastructure investment, which had predominated throughout the 1990s. As concessionary funding became available again, many countries opted for publicly funded projects, rather than their private sector counterpart; for instance, Egypt has seen its current five-year power investment implemented by the incumbent, state-owned utility, and supported entirely by concessionary loans.

The majority mainstream economists trust that recessions are caused by insufficient aggregate demand in the economy, and support the use of the expansionary macroeconomic policy in a recession period. Strategies favoured for moving an economy out of a recession differ depending on the economic school followed by policymakers. Monetarists would support the use of expansionary monetary policy, whereas Keynesian economists may support increased government spending to promote economic progress. Supply-side economists can propose tax cuts to endorse business capital investment. Once interest rates fall to zero, conventional monetary policy cannot be used and government should use other measures to encourage revitalisation (Coudouel, 2006).

A recession is a factor in explaining the recent trends in investment; the investors will be discouraged from investing in the economy, for instance investing in the electricity projects (Willis, 2011; Coudouel, 2006; Momoh, 2010). Accordingly, participants were asked to indicate the recession effect on Libya's electricity projects and the findings from the interviewees, showed that the recession has had a minor impact on Libya's electricity projects, as they ranked low among the affecting factors according to the questionnaire survey. One of the senior manager suggested that:

> "*Even though the recession might have an impact on the construction of electricity projects in different countries, the Libyan government must not allow this* to *happen in Libya, especially as it is an oil-rich country".*

As the global financial crisis continues, many countries are expected to decrease foreign aid and focus on domestic issues. The protectionist tendencies are common during harsh economic times and countries prefer to look after their own citizens. John

Clancy, of the European Commission Humanitarian Aid and Development noted, the concern that our holds is that not only the EU states but also the broader donor community become very inward-looking, in the sense of their home policy, to an extent understandably, because they now have to deal with the economic impact on various investment projects (Momoh, 2010).

6.3.2 The effects of oil prices on Libya’s electricity projects

Economists have shown great concern regarding oil prices and they have tried their level best to ensure that prices are stabilised, as though the process could slow the current fragile global economic status. As a rule of thumb, every $10 increase in price of a barrel of oil will cause a reduction in the economic growth especially in the gross domestic production by almost 50 per cent within two years. If the price of oil and of paying workers is high these would mean that the cost of producing electricity would be very expensive. According to Jan (2004) cost set the floor far the price that the company can change for its products. The project investor wants to charge a price that both covers all its cost for producing, distributing and selling the product and delivers a fair rate of return for its effort and risk. A pricing strategy many organisations work to become the “low cost producers” in-their industries. Investors with lower costs can set lower prices that result in greater sales and profits.

These costs were attributed to each customer and allocated to products based on the volume of each product purchased by a particular customer. The consumers should be made part of pricing decisions of a company. Pricing may be made too heavy and influenced by cost, when all the cost that led to production is high the final price is also high. This is to cater for what is used in the manufacturing of the product. All the cost should be bearable, complexity of pricing, sourcing or goods and services should not be made complicated so that unnecessary things are added to the final price. A good pricing policy on products is one that benefits the manufacturers and at same time is favourable to the consumer (Willis, 2011; Michal, 2000).

Jarn (2004) found that a company's costs take two forms; fixed and variable costs. Fixed costs (also known as overhead) are costs that do not vary with production or sales level. Variable costs vary directly with the level of production and variable costs are influenced by fluctuations of prices. In case the prices are high during a certain period, this would mean the variable cost is directly influenced. Total costs are the sum of the fixed cost and variable costs for any given level of production. Management wants to charge a price that will at least cover the total production costs at a given level of production. The company must watch its costs carefully. If it costs the company more than the competitors to produce and sell its products the company will have to charge a higher price or make less profit, putting it at a competitive disadvantage.

To price wisely management needs to know how its costs vary with different levels of production. For procurement managers, developing variable costs to use in pricing decisions is frequenting a frustrating process often many products are made in same factory and the allocation of costs by this capital department but also to customers so that a manager can determine the cost to serve a particular customer. In special needs including packaging and loading, order processing and invoicing post sale and the cost of offering credits, these costs were attributed to each customer and allocated to products based on the volume of each product purchased by a particular customer (Coudouel, 2006).

As mentioned above this means that if the price of oil and of paying workers is high these would mean that the cost of producing electricity would be very expensive in Libya. To find out if the changes in oil prices had an impact on the construction of new electricity projects, the participants were asked to indicate the extent of importance regarding the oil prices on electricity projects in Libya. Opinions of the participants were different, some of them felt that there is an impact of oil prices and of some of them do not. Some participants felt that the impact of increasing oil prices and the country's quest for the export of oil were reasons to convert many of the power plants from oil to natural gas in order to reduce costs.

6.3.3 The development of other infrastructure

According to Al. Azzam, (2002) there are a number of growth variables that are directly related to the cost and availability of electricity. A policy that ensures that the cost of electricity is lowered in the economy will lead to the growth of other infrastructure like schools, hospitals among others. The availability of electricity helps in opening up the economy to a myriad of investors. It ignites the growth of other sectors. This will mean that there will be a need to see the demand for electricity increasing. The number of projects will therefore increase.

Reduced costs of electricity will reduce the costs of living in the economy. When the cost of electricity is high then the cost of production will also be high. Robbins and Publications (2007) stated that high cost of electricity means that the expenses in production are increased. Since the firms are in business to make profit it is likely that these costs will be transferred to the customers. Therefore, cheap costs of electricity will result in the lowering of most of the basic products in the economy. This will result in the costs of living to be cheaper than before. The government of any country must therefore look at all the available options to ensure that the right policy is adopted. All the internal and external factors should be taken into consideration. The costs of constructing major electricity projects should be looked at in comparison to the revenues which are expected to be produced from the viability of a successful project (Publishing and Agency, 2012).

According to the above, participants were asked to indicate the effect of the development in other infrastructure on the electricity projects in Libya. From the verification results, an investigation of the external determinants of electricity projects in Libya showed that the most effective factor was the improved development of other infrastructure. Participants acknowledged that the main driver for the production of electricity is the creation of buildings and expansion of cities, the participants pointed out that in Libya the problem lies in poor planning and administration of the state, for example, when the state went into the construction of residential buildings, it did not realise at the same time that there must be planning to increase the capacity to generate electricity production; this represented a pressure on the production of electricity, causing power outages.

6.4 DISCUSSION

This chapter looked at the supply side of electricity in an attempt to explore the internal and external determinants of electricity projects and the impact of these determinants on electricity projects in Libya during the period from 1980 to 2010. This chapter explained that there are problems which have faced and are still facing the electricity projects in Libya.. The problem is the people living in scattered cities and villages need a lot of money for the construction of new power projects or even maintenance and development of existing projects. The government of Libya has not constructed enough electricity projects to meet the level of electricity demand. Furthermore, the government of Libya has not adopted regular mechanisms to deal with the consistent upsurge in the demand.

The problem can only be solved if the current government manages to construct the proposed power units in the country, and foreign companies that were working on these projects should also be requested to come back to Libya. The problem confronting development of the electricity projects at this time in Libya has three components. The first is the national significance of the projects as a physical resource. The second is the conflict arising politically from within. The third is the lack of consideration given to the specific resource management issues associated with the projects within the government plans and policy statements.

Currently, the supply in the country is not enough to meet the demand for various activities that go on in the country. The demand is high as compared to the number of people that are in need of the electricity projects, which means the government has no option but to initiate more projects to deal with the issue of shortage. The discussion in this chapter explained that the internal determinants of electricity projects in Libya are electricity demand and political factors. The external determinants are recession, oil prices and the development of other infrastructure.

The number of projects which are being initiated in Libya is mainly informed by the increased demand which has been recorded in the country, the population factor has the most impact of all the determinants of electricity demand, and also has a main influence on electricity production, in addition, income comes in the second rank after population in regard to the factors that are affecting electricity production and consumption.

Political factors play a role in electricity projects in Libya. Conflicts, foreign affairs of the Government of Gaddafi, the economic blockade, the air embargo throughout the nineties and the administrative corruption and theft of the funds that could be used to develop electricity production, all of these factors make it impossible for the investors to carry out electricity production projects or even renovation and maintenance of existing projects.

The electricity tariff does not have role in attracting the investment in electricity new projects, because the electricity company was established to achieve social and national objectives, where electricity prices have remained stable for long periods, this means that real electricity prices tend to decline over time.

Recession has a minor impact on Libya’s electricity projects, as they ranked low among the factors affecting Libya’s electricity projects. Despite the delay in the many electrical projects in the nineties, the recession is not the main direct reason.

The oil prices have an impact in the long run on the electricity projects in Libya while there are no signs of the impact of oil prices in the short run due to the electricity sector being powered by the state, which is an oil country. The impact of oil prices in the long run is represented in the country's quest to convert many of the power plants from oil to natural gas to reduce costs.

The development of other infrastructure was the most effective factor of the external determinants on the electricity projects in Libya, where the development in the residential sector has had a greater impact in increasing electricity projects during the last four decades. Also the deregulation of the economy at the beginning of the nineties led to the development of the commercial sector which means an increase in demand for electricity which is a pressure to start new power projects.

6.5 CHAPTER SUMMARY

This chapter discussed the main determinants that affect the electricity projects in Libya in the period between 1980-2010. The findings showed that there is a combination of five types of factors (the electricity demand, political factor, recession, oil prices, and the development of other infrastructure) that have an effect on electricity projects in Libya. The following chapter will provide an explanation of the proposed framework for electricity organisations in Libya, the validation of the results of the study and a discussion of the implications of the proposed framework resulting from the validation process.

CHAPTER SEVEN: FRAMEWORK FOR ELECTRICITY ORGANISATION AND VALIDATION

7.0 INTRODUCTION

This chapter introduced an explanation of the proposed framework for electricity organisations. This framework's components were based on the results of this study. It, therefore, focused on how the validation of the results of this study and the validation of the proposed framework to test it in the practicality, usefulness, clarity and appropriateness of the proposed framework to the electricity organisation in Libya. The chapter commences with a debate on the rationale of the framework and discussed aspects considered while proposing the framework. Then, the chapter discussed the implications of the proposed framework resulting from the validation process. Finally, the chapter displayed discussion and summary for the chapter.

7.1 THE RATIONALE OF THE PROPOSED FRAMEWORK

The regression statistics show that Libya is in dire need of an electricity framework that can meet the residential and commercial objectives of Libyans. To recap, the average real price of electricity demand, the real value of the imported electrical appliances, GDP, population, the temperature difference and the lagged electricity demand explicitly show the variation in electricity demand in Libya. The factors that have led to the current status of electricity supply and demand vary from internal factors (demographic and political factors) to external factors (such as changes in the international politics and global economy). The price elasticity of demand and income elasticity of demand in the long run are greater than elasticities in the short run, implying that these variables have a significant impact in the long term. The average price of electricity and the population are significant determinants of electricity demand. Taking into consideration the impacts of these factors on the demand of electricity in Libya and the projection of future demand, it is imperative that an appropriate electricity framework be developed. The purpose of the proposed electricity framework was to provide:

- The basis for stable supply of electricity to the citizens and their businesses;
- The basis for projection of future electricity demand in the country; and
- A model for further development of the electricity sub-sector.

7.2 ASPECTS OF THE PROPOSED FRAMEWORK

The study results showed that the total electricity production in Libya has increased by 49.8 times from 1970 to 2010, however, the results of the study also pointed out that there was a significant increase in demand for energy, which turned out to be more than quantity supplied, where various cities and regions of the country have suffered and continues to suffer from periods of interruptions in electricity supply. In addressing that, there was a need to propose a framework for electricity organisations that would:

- Highlight the demand requirements for electricity organisations to define the considerations that can be taken into account when facing the electricity demand; and
- Establish how electricity organisations can adopt regular mechanisms to deal with the consistent upsurge in the demand.

The study findings indicated that in order to formulate the appropriate integrated framework for electricity organisations, it is necessary to consider the factors that affect the demand and supply of electricity in Libya. Figure 7.1 summarises the main components of the framework that emerged from this study. Firstly, from the aspect of the demand the study found that there is a diverse set of factors that affect the electricity demand in Libya. These include the average real price of electricity, the real value of the imported electrical appliances, GDP, population, the temperature difference, and the lagged electricity demand. Secondly, from the aspect of the electricity supply the study found that there is a diverse set of factors that affect the electricity projects in Libya or even the development of existing projects. These factors include electricity demand, political effects, recession, oil prices and improved development of other infrastructure.

The study showed that the factors affecting the demand have the effect of a double effect on the electricity sector, the first impact on the demand side and the other effect on the supply side of the electricity, which shows that there is importance for the study of the determinants of demand and the impact on the economy of any country. The literature supports the view that any policy formulation or electricity framework must consider the factors affecting the demand for electricity. For example, in China there was a study using a macroeconomic approach to develop a long run electricity demand model to analyse the main factors affecting demand for electricity (Lin, 2003). Lin reported a stable and significant relationship among relevant variables after China's economic reforms three decades ago to make all variables more responsive to market forces. Since the reforms were initiated in 1978, the demand elasticity of GDP has been estimated as 0.8 which is lower than the pre-reform period. This implies that Libya can also improve the demand and supply of electricity through structural changes in the economy.

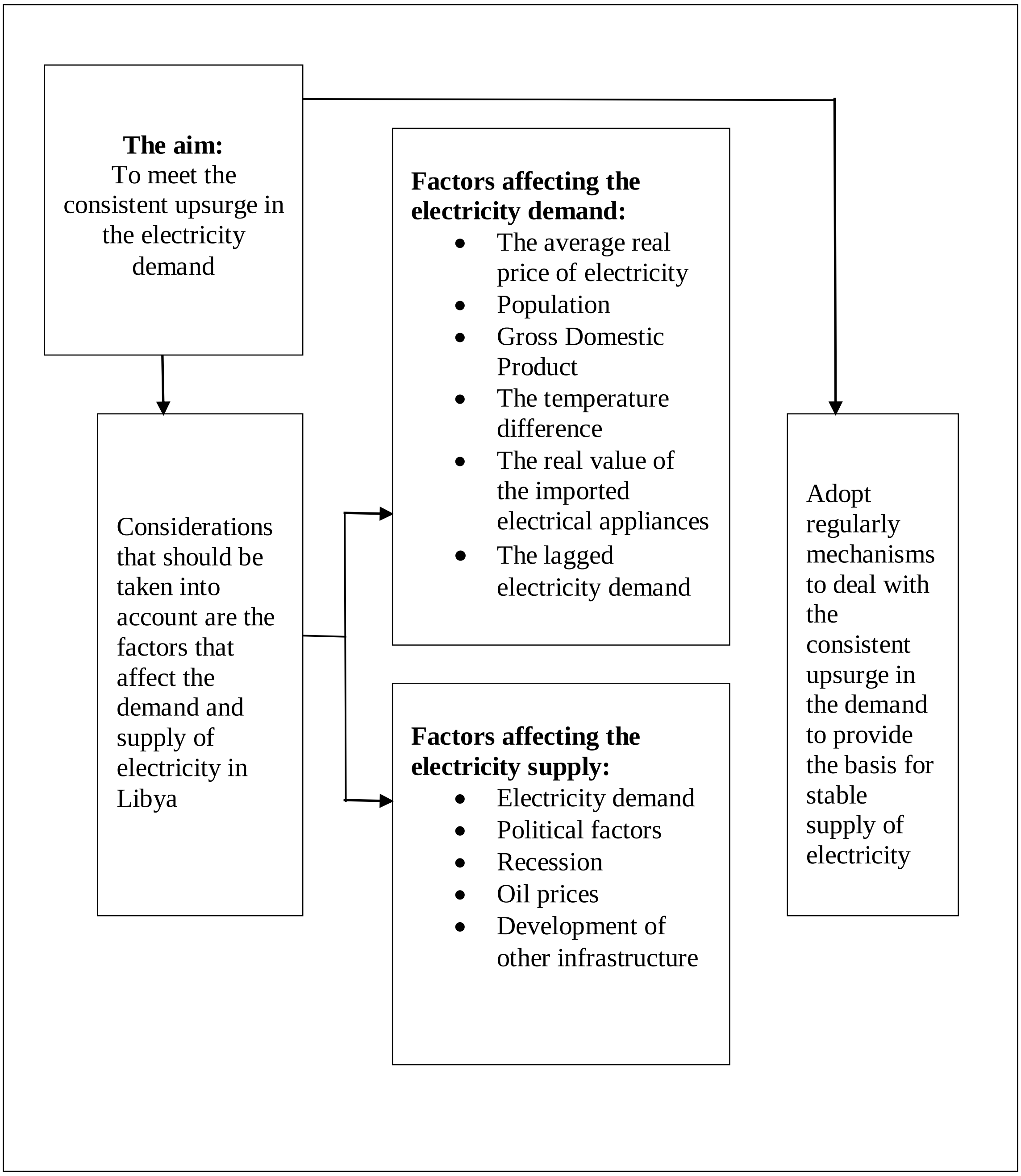


Figure 7.1: Represents the aspects of the proposed framework

Hondroyiannis (2004) found out by focusing on the issues of structural stability, price and income sensitivity for both the long and short run for Greece, residential demand for electricity is affected by changes in real income, real price levels and average temperatures in the long run. Mohammadi (2009) examined the long run relationship and short run dynamics between electricity prices and different fossil fuel prices such as coal, natural gas and crude oil using annual data for the US. The study showed a strong relationship between real electricity prices and coal and bi-directional long run causality between these two variables. Other important studies that examine the demand for electricity include: Xiaohua and Zhenmin (2001); Jumbe (2004) and Holtedahl and Joutz (2004).

This study showed that the average real price of electricity affected the demand. These findings correlate with those reported in existing literature on the effects of average real price of electricity on demand support (Donatos and Mergos, 1991; Christian and Michael, 2000; Halvorsen and Larsen, 2001; Lin, 2003; Hondroyiannis, 2004; Mohammadi, 2009). Donatos and Mergos (1991) examined the determinants of residential electricity consumption in Greece over the period 1961-1986. They estimated the elasticities of residential demand for electricity using a single equation model with the ridge regression method. They reported that the residential demand for electricity in Greece was price inelastic and income elastic. They also concluded that the population of consumers played a very important role in the expansion of electricity consumption. Christian and Michael's (2000) analysis of the demand of electricity in China showed that structural adjustments in the economy can lead to changes in the demand for electricity. Such changes include deregulation and price increases in the electricity sector. These changes can be seen in the Libyan economy where the economy has become more liberal in recent years. This has implications on the demand and supply of electricity in Libya.

The regressions results in the present model show that GDP is one of the variables that causes variation in electricity demand in Libya. The country's GDP has been frequently used to estimate electricity demand of that particular country.

7.3 THE AIM AND OBJECTIVES OF THE VALIDATION

Validation of the study was conducted in order to increase the reliability of the electricity framework. The aim of the validation was to test the proposed framework's practicality, usefulness, clarity and appropriateness to electricity organisation in Libya. To achieve that, the following objectives were to be achieved to:

- Get views from participants about the results of the quantitative method which estimates the determinants of the demand function and the results of the qualitative method which examines the effect of internal/external determinants of electricity projects in Libya;
- Collect expert opinions on the proposed framework components;
- Explore, in greater detail, the opinions and attitudes of experienced personnel towards the usefulness and appropriateness of the proposed framework; and
- Discuss the implication of the proposed framework's implementation strategy in real life scenarios.

7.4 VALIDATION METHOD

Different studies use different models to estimate the electricity or the electricity market of a country. However, the methods used need to be validated in order to give quality, credibility, and trustworthiness to the research. There are many different validation methods whose use depends on the design of the study. Validity may mean different things in different subjects and in different settings (Nanda *et al.*, 2000). One way of performing validation on the results of this study and the proposed framework was the use of focus groups. Different studies examine the advantages and disadvantages of focus groups as well as when they should be applied (Gibbs, 1997). According to Gibbs (1997, p.8), "*the main purpose of focus group research is to draw upon respondents' attitudes, feelings, beliefs, experiences and reactions in a way which would not be feasible using other methods*,". Gibbs (1997) noted that focus groups elicit a multiplicity of views and emotional processes within a group context. As the participants of the focus group take initiative, the moderator may lose control. In this regard, Morgan and Krueger (1993) suggested that some problems associated with focus groups such as prior acquaintance and taking control by the participants can be best handled by a moderator with highly developed professional skills.

Contrary to the popular belief that focus groups are cheap and quick, Morgan and Krueger (1993) opined that they require planning, effort, and resources in order to be successful. In addition, focus groups need as mentioned previously, skilled moderators who can take charge of focus groups whose participants are of diverse backgrounds and capabilities. The major role of the skilled moderator is to create and control a free and permissive atmosphere in which the focus group can express their thoughts and feelings freely. The role of focus groups is to collect concentrated discussion in a natural setting on the topic of interest to the researcher.

In a situation like the evaluation of the electricity demand in Libya in which the role of the researcher was to understand the influential factors of electricity demand, when the goal is to generate theories or explanations, focus groups and other qualitative methods are the most appropriate tools (Scott and Garner, 2012). Contacts were established using telephone calls. The contacts were conducted with twenty-five participants. The participants were given a chance to read and to take a decision on whether to participate. Participants were served with a copy of the validation questionnaire (*see Appendix L*) and an information sheet explaining the purpose of the study (*see Appendix R*). The research participant's recruitment letter (*see Appendix N*) and participant consent form (*see Appendix P*) were issued to participants. The research participant's recruitment letter and the participant consent form were presented in Arabic. Only twenty participants finally indicated interest in participating in the focus group. Then, telephone calls were conducted to schedule the time and the place for focus groups. These participants comprised head managers, managers, technicians, engineers, technicians and other staff members in GECOL. There were individuals who had professional understanding of issues to do with electricity and were involved in policy formulation or in the construction of the projects.

The validation took place after the interpretation of findings of the study. This involved presenting the results obtained from estimating the demand function and the results obtained from the questionnaire survey. The proposed framework presented to participants in Libya was achieved through focus group discussions. It is worth mentioning that the validation was used to assess the effective factors for the electricity demand and the determinants of electricity projects in Libya. A total of four focus groups discussions were carried out during the month of April of 2014, each group included five participants.

The average time to complete the focus group discussions was two hours. The discussions were organised to be in three phases. During the first phase, discussions began with an introduction of 10-15 minutes by the researcher. An overview of the study, the aim, the objectives, the methodology used and the results of the study were presented and explained to the participant. During the second phase; the results of the study were discussed with the members of the focus group to validate the results in order to give quality and credibility to the study.

During the third phase; the proposed framework was presented to the participants for further discussions on how it could be implemented. During the fourth phase; a questionnaire was distributed which contained the same questions that were given to them when they were invited to participate in the validation process. This phase aimed at enabling the participants to provide their opinions in a discreet manner devoid of other participants influence. A set of twenty-three questions was presented to participants (*see Appendix L*). This phase also enabled the researcher to obtain the views of the participants more accurately and clearly, especially on the questions that had answers with a 5 point Likert scale ranging from strongly agree (1) to strongly disagree (5). The 5 point Likert scale was adopted because it allowed for a greater degree of flexibility (Harry and Deborah, 2012).

7.5 VALIDATION RESULTS

The participants equally highlighted the need for practitioners and scholars to constantly have a rethink on improvement measures for stable supply of electricity. The participants stressed that the dynamic of the energy industry makes it mandatory for its stakeholders to be constantly prepared for the consistent upsurge in the demand for electricity. Based on the discussion, the following key issues emerged from the discussions:

7.5.1 Estimation of electricity demand function

The results obtained from estimating the demand function were discussed and investigated during discussions of focus groups, during the four meetings, there was a consensus that there was a consistent upsurge in the electricity demand in Libya for over three decades. Almost all the participants in the four groups agreed that the variables identified in this study, the average real price of electricity, the real value of the imported electrical appliances, GDP, population, the temperature difference and the lagged electricity demand are the main factors that directly affect the demand electricity, a majority of participants agreed that the price of electricity, the population and income are significant determinants of electricity demand. Participants noted that changes in income will greatly influence the amount of electricity which is being purchased by the populace. Where there are any changes in income then there will be changes in the electricity consumption in Libya in two main ways. The first one is that when there is a change in income, there will be an inducement to change the intensity of using electricity consuming appliances as they should ensure they evaluate the adoption of the constrained budget. The second one is that the change in income will result in an effect on the stock of various electricity consuming appliances, and consumers are in a position of purchasing either more or fewer electricity intensive devices.

Participants felt that there is also an increase in demand for electricity with the socio-economic development which includes the urbanisation, industrialisation and literacy rates. They indicated that consumption of electricity in the country significantly goes up with the increase in the level of urbanisation. In Libya, there is a lot of energy used by a number of households which comes from fuels like candles, kerosene, gas, coal and biomass. The participants affirmed that the urban households consume a higher share of electricity and the fossil based energy sources as compared to the rural households with the main transition to the modern energy types in the urban locations with the increase in education and income and increase in people wanting to use the technology and home appliances and computers.

During the discussions of focus groups, participants highlighted that climatic factors are very important. Very low temperatures in most cases raise the consumption of electricity in Libya and that the maximum temperatures are in most cases associated with the demand for electricity though the minimum temperatures have insignificant effect in the lowering of electricity in other countries compared to Libya. The variations in temperature over a given period of time, but not in the areas affected by the demand for electricity in the country. The climatic factors have the significant positive effect when it comes to the consumption of electricity in Libya during the period where rationing is common. The process of urbanisation is expected to drive demand upwards for the electricity through the provision of higher access to the grid and also an upsurge in use of electrical appliances as the exposure to advertising and media increases.

During the discussion in one of focus groups, the point was raised that the style of construction in homes, shops, buildings and government departments does not take into account ways to help conserve energy in buildings; participants indicated that in the past the buildings were constructed by old ways that retain heat in winter and retain the cold in summer, but at the moment the buildings are constructed in ways that are not suitable for energy conservation, leading to the use of more energy. Participants felt that there is ignorance and the failure in the state to conserve energy, the state does not have a culture of energy conservation to educate its citizens. The increased level of electricity demand therefore is no doubt expected to be mainly driven by prices of electricity, income, population, education, size of the household, their dwelling type and size, weather variables, alternative fuels and the cost of the availability of suitable appliances.

7.5.2 Effect of internal and external determinants of electricity projects in Libya

7.5.2.1 Electricity demand effect on Libya’s electricity projects

The focus groups' discussions emphasised the importance of electricity demand and there was an agreement on the need for its inclusion as an integral component within the framework. From the validation of the findings derived from the focus groups almost all the participants in the four focus groups agreed that the population level is the most influential impact regarding the determinants of electricity demand, and also has a main influence on electricity production, then the income. Moreover, the price of electricity demand comes in second rank after the population and then the rest of the determinants regarding the demand come in the next rank in terms of the effects on electricity production and consumption.

Generally, it was agreed that the general electric company of Libya must be mindful of the rate of growth in the determinants of electricity demand and should be working towards the growth rate of the generation and production of electricity and ensuring that this is greater than the rate of demand growth, in order to avoid interruptions in the country's power supply.

7.5.2.2 The effects of political factors on Libya’s electricity projects

During the discussions, there was a consensus that the result from the internal and external Libyan practices and policies had played a role in electricity projects in Libya. External political conflicts have resulted in no development because parts of the country have no supply of electricity and especially in some rural areas. Lack of electricity in these rural areas has resulted in lack of improvement and make the country lag behind, economically. The participants were further asked about their opinions on energy policy implementation, their views focused on two points:

- The first point was conflicts with foreign powers of the government of Gaddafi, which has caused an economic blockade and the air embargo throughout the nineties. The political wars make it impossible for the investors to carry out electricity production projects or even renovation and maintenance of existing projects; and
- The second point was the government of Libya is clothed with corruption and the funds that could be used to develop electricity production and supply is used firstly for the people in high political seats whilst other people face frequent electricity outages.

The four focus groups discussed the electricity situation after the February revolution. According to the participants some of the current electricity projects in the country included Daewoo, Siemens and Gama Electronics. These companies stopped their operations as a result of the revolution which rocked the country in 2012. This resulted in a higher interference with a number of government and private projects in the country. The completion of some of the projects will crucially depend on the political condition in the country. If there is no peace then it is likely that a number of these projects will not continue.

Finally, the focus groups also stressed that the completion of these projects will depend on the willingness of the companies to come back and continue with the projects. The main concern has been tagged on the issues to do with security, which the government has not managed to solve. Financial support is very important when it comes to the completion of such major projects. Being a dependent variable in the completion of the power plants, it is important that there is availability of money to ensure completion. A larger proportion of the company's budget is currently on the reconstruction of the major infrastructure projects which were destroyed during the revolution in the country.

7.5.2.3 Electricity tariffs effect on Libya's electricity projects

Although participants agreed that the electricity tariff was one of the factors causing a rise in demand for electricity, it was stressed that the electricity tariff does not have a role in attracting the investment in electricity new projects, because of its low value. According to the participants, the cost of producing one kilowatt of electricity is more than the price that is offered by Libyan General Company for an electricity tariff which does not give any motive to attract companies for the supply of electricity. Therefore, any other company operating in the electricity sector is limited to work on the construction of new plants or maintenance for the benefit of the company Libyan General Electric.

During the discussion sessions, the participants highlighted that with the growing trend of electricity demand, it is not appropriate to impose a significant increase in prices, especially that Libya is still a country seeking to develop its economy and encourage small industries. In this particular category most participants agreed that to face the increase in demand for electricity, the company needs to start developing power plants and the construction of new power projects.

7.5.2.4 Recession

There was a consensus that the result from the verification was closer to reality. According to the participants, the recession had a minor impact on Libya's electricity projects. There was an agreement on the need for its inclusion as an integral component within the framework. According to the participants, contemporary approaches on electricity must constantly cater for all categories of the factors that may affect the production and supply of electricity.

7.5.2.5 The effects of oil prices on Libya's electricity projects

Results of the questionnaire from the previous chapter showed that there was a difference in opinion about the impact of oil prices on Libya's electricity projects. Interestingly, when the results were presented to the focus groups, there was the same difference of opinion about the impact of oil prices. The following is a description of the most important opinions of participants during the four focus groups discussions:

Comments from participants that support the effect of the oil prices:

> The manager in the production department claimed *"the rise in oil prices had a positive impact at the outset, in terms of providing liquidity to the State, but the effect after work was negative in the change in the foreign currencies exchange rates in 1999, which has increased the production costs".*

> Another manager also emphasised the effect of the foreign currencies exchange rates due to oil prices and stated that: *"the change of the exchange rates has*

negatively affected our performance. For instance, the cost of raw and other production materials has increased about four times due to this change. This has caused a major problem for the company in that 85 per cent of the raw materials come from outside the country, in addition, to an increase in the wage of foreign workers ".

Comments from participants that do not support the effect of the oil prices:

> One of the managers stated that: *"the electricity sector in Libya is a strategic sector that offers a service to the community which should not be an entity operating under market conditions".*
>
> Another highlighted that, *"I believe that oil prices had no effect, since fluctuating oil prices in the nineties. Then there was a rise in oil prices during the year 2004 and even 2007, then a drop in prices in late 2008 and the first half of 2009. Thus, during the periods of high and low oil prices the procedures for the establishment of new projects were as usual in the company, were and still are complicated procedures and take a long time in the planning and implementation".*

Generally, the results indicate that there is the effect of oil prices in the long-term, while there were not noticeable signs of the impact of oil prices in the short-term on the electricity projects because the electricity sector is supported by the state.

7.5.2.6 The development of other infrastructure

A consistent challenge for electricity projects and on which the participants agreed was the constant developments of other infrastructure during the last four decades, especially the development in the residential sector. Furthermore, deregulation of the economy at the beginning of the nineties led to the development of the commercial sector which increased the demand for electricity. These factors justify the need to develop new power plants to support their growth. It is noteworthy that structural adjustments to facilities such as the construction of homes, shops, buildings and government departments need to take into account ways to help conserve energy in buildings. The old style of buildings was popular because it had the ability to retain the heat in winter and the cold in summer. Contemporary buildings are not suitable for energy conservation, leading to the use of more energy. Therefore, new building styles that conserve the energy will help in reducing the strain on the available electricity supply.

7.6 Limitations

The small numbers used in the focus groups limit the ability to generalise the opinions of the larger population. In addition, the tendency for certain types of socially acceptable opinion to emerge, and for certain types of participant to dominate the research process undermine the use of the methodology. There is also uncertainty about the accuracy of what participants said, where all the suggestions and comments provided represented just the personal thoughts of the participants. As such, their opinions may be biased by the presence of very dominant and or opinionated members. Therefore, it was crucial to analyse the data collected from the focus groups in ways which do not ignore these limitations.

7.7 KEY IMPLICATIONS OF THE PROPOSED FRAMEWORK

The focus groups discussed the issues identified in this framework exhaustively in the four focus groups meetings. There was general consensus that Libya has witnessed a consistent upsurge in the electricity demand over the past three decades, as well as facing frequent interruptions in the power supply during the same period. The participants noted that this problem needs to take the initiative to resolve the issue before it gets worse in the future. From the findings, participants suggested that the aspects of the proposed framework provide a significant step towards improving the electricity sector performance.

From the validation results, it was found that the proposed model with a number of conditions and initiatives is conducive to providing the basis for stable supply of electricity to the citizens and their businesses, and providing the basis for projection of future electricity demand in the country. The four focus groups believed that the energy sector and the Libyan state should take into account aspects of the proposed framework in order to address the continued escalation of the electricity demand in the country. The following are the actions which were proposed:

- Economic planning;
- Socio-economic development policy;
- Development of new power plants and expansion of the existing capacity; and
- Improved development of other infrastructure.

As a result, participants suggested that the earlier framework be reorganised to reflect these actions as shown in Figure 7.2

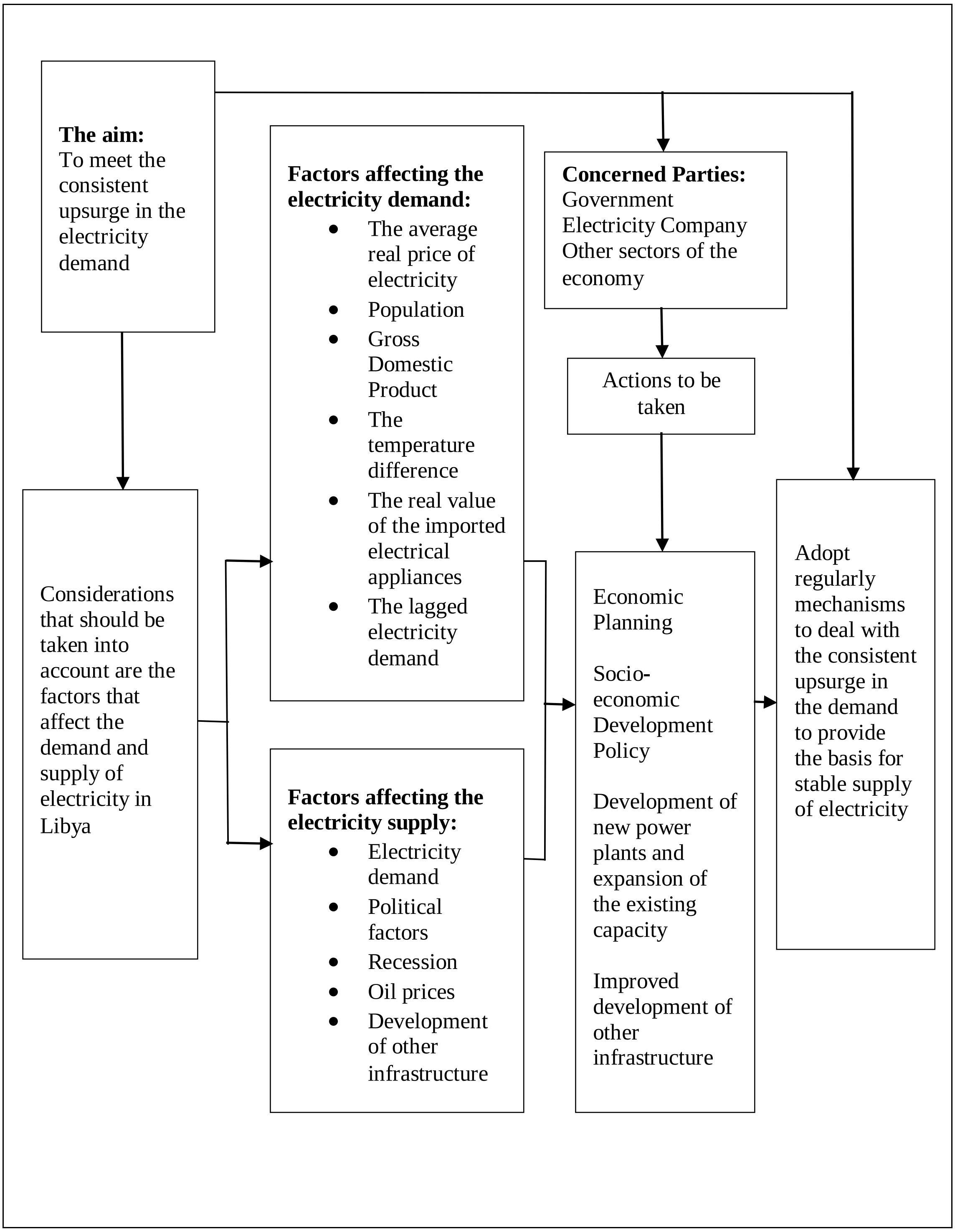


Figure 7.2: Represents the revised aspects of the proposed framework

Figure 7.2 represents the revised aspects of the proposed framework. The framework consists of the various influences on electricity demand and the various influences on the electricity supply and parties responsible. The key factors identified to have significant influence on electricity demand are price elasticity, population, income, GPD, and changes in other sectors of the economy. These factors require a sound socio-economic development strategy, pricing strategy, upgrade or development of new power plants, and improvement in other infrastructure projects. These interventions are a responsibility of the government, the electricity company, and the other sectors of the economy.

Participants agreed that the average real price of electricity, the real value of the imported electrical appliances, GDP, population, the temperature difference, and the lagged electricity demand are the main factors that directly affect the electricity demand with a majority indicating the low price of electricity. The increasing population growth rate and income are the most significant determinants of demand. Besides, the continued improvement of income among the citizens implies that the residential electricity demand will continue to rise. This is because changes in income will highly influence the amount of electricity people purchase, implying that any further changes in the income of Libyans will lead to changes in the electricity consumption. The increased income will influence the citizens to increase the intensity of electricity usage as they purchase more electrical appliances because they can afford to purchase them. It is worth mentioning that all of the above have serious implications on the production and supply of electricity and most notably, policy formulation. The government of Libya and energy organisations need to plan the supply of electricity according to the trends in the economy and individual improvement of income of the citizens.

The participants also believed that as the rate of socio-economic development increases, the demand for electricity is expected to rise. Urbanisation, industrialisation, and literacy rates are some of these developments which will exert more demand pressure on the electricity supply. The participants claimed that the government should take into account the urbanisation rates in Libya in the energy policy formulation. Electricity companies can also take a cue from the urbanisation trends and other socio-economic developments to plan the delivery of electricity according to the rising demand.

In general, the participants welcomed the proposed framework as a solution to meet the rising demand for electricity. Participants noted that the demand for electricity in Libya has been rising for the past three decades. The import of this fact is that demand will continue to rise as the Libyan becomes more sophisticated. The GDP continues to grow which will put more pressure on energy organisations to produce more electricity to meet the demands of the economy. As the participants indicated, the supply of energy is directly correlated with the country's economy growth. In this regard, the country needs more supply of energy in order to sustain its economic growth. In the context of Libya, this is urgent because there are symptoms of insufficient supply of electricity (for example, electricity rationing). The participants claimed that the Government and the electricity company have two options to resolve this problem:

7.7.1 Expansion of the production of the existing electricity plants

The expansion of the production of the existing electricity generating plants in theory appears to be the most sensible strategy for the electricity company in the short-term. However, the power generating plants have been unable to meet the current demand. It appears that the mitigating strategy for energy organisations has been the rationing of electricity. While the improvement of the current power plants is likely to solve the electricity supply problem, it would be a short-term strategy that will soon be required to change.

7.7.2 Development of new power plants

An alternative to the expansion of the existing power generation plants is the establishment of new plants in the future. As it has been established, electricity demand in Libya has been rising for decades as the economy has become more sophisticated. Therefore, it is easy to project the energy demands of the country in the next decade or more. In this regard, the new scalable power generation plants will have the capability to address the country's electricity needs both in the medium and long-terms.

Based on the revised framework, the government, energy firms and other stakeholders need to work together in order to get a long lasting solution to the electricity demand challenges. Consequently, an integrated approach is required to bring together the various stakeholders. The responsible parties are influenced by various factors. Population pressure, GDP, and household income are socio-economic factors which require socio-economic development policy. The government needs to carry out activities that will lead to socio-economic development. This could be economic reforms through planning, which takes into account the factors affecting the electricity industry, together with improved development of infrastructure in the other sectors of the economy.

7.8 DISCUSSION

This chapter presented the validation of the proposed framework for the electricity sector in Libya. The aim was to validate the results of the study and to use the validation outcome to improve the proposed framework and bring it closer to the reality of practicality. The validation process was accomplished using focus group discussions.

The participants affirmed that Libya has undergone a great transformation over the last four decades. The economy has grown tremendously and so has the population. As the economy in terms of GDP expanded, the income of individual citizens improved. In addition, the liberalisation of the economy in the early nineties attracted private sector investments. There is a rapid growth in various sectors in the country. These factors have only served to put pressure on the existing energy infrastructure. From regression statistics, it can be deduced that the electricity demand will continue to rise for many years to come.

The increased demand for electricity in Libya compels the government, Electricity Company and other sectors of the economy to come up with a sustainable framework to meet the energy demands of the country. While the company have the option of expanding the productivity of the current facilities to meet the electricity demands, it is only a short-term mitigation measure which cannot meet the expected demand. Building new power projects is the only long-term solution that will address the present and future energy needs.

The main outcome of the validation was that the proposed framework was found practical and provided a methodology for solutions that can be taken by the electricity company and the government to adopt regular mechanisms to deal with the consistent upsurge in the demand and to provide the basis for stable supply of electricity.

7.9 CHAPTER SUMMARY

This chapter provided an explanation of the proposed framework for energy firms and the method adopted to validate the framework. The proposed framework was validated to test it in the practicality, usefulness, clarity and appropriateness to the electricity organisation in Libya. In addition, the chapter discussed the implications of the proposed framework resulting from the validation process. In the next chapter, recommendations and further research work are presented.

CHAPTER EIGHT: CONCLUSION AND RECOMMENDATIONS

8.0 INTRODUCTION

This chapter presented the main findings of the research based on the research aim and objectives. As noted in chapter one, the main aim of the research was to examine and identify key determinants affecting the demand for electricity in Libya, based on the findings, the study proposes a framework for the electricity sector. In order to achieve this aim, the following objectives were developed:

- Review current practice in the Libyan energy sector and compare it with that of the United Kingdom;
- Identify factors contributing to the econometric framework of demand function for electricity in Libya;
- Compare the tracking ability of the demand for electricity model with other models that can be developed for Libya;
- Examine the effect of internal/external determinants of electricity projects in Libya;
- Propose a framework for electricity organisations in Libya ; and

The thesis was divided into eight chapters. Chapter one presented an explanation of the rationale behind the research. Potential implications of the study in the real world were evaluated and discussed.

The first objective, reviewed current practice in the Libyan energy sector and compared this to that of the United Kingdom. This was achieved in chapter two. The second chapter reviewed the entire energy sector in Libya, this entailed the concept of energy and energy sources, with Libya as the point of reference. The research further discussed the role of energy and its sources play in the Libyan economy. There was a discussion on the evolution reserves of oil and natural gas in Libya and other sources of energy and their development and production. That discussion also involved the development of electric power in Libya with an analysis of the power plants, transport, distribution networks and electricity projects in Libya. In addition, the chapter compared the present energy practices in Libya with the energy sector in the United Kingdom.

The third chapter discussed the demand for electric power in the economic literature and included the inherent characteristics of electric power and the determinants of electric power in Libya, including the roles played by income, imported appliances, population growth and economic growth. The electricity industry in Libya and the factors that affect it such as government policies, pricing, lifestyle and political factors were also discussed.

The fourth chapter discussed the research methodology that incorporated the economic theories and methods of electricity demand, the research techniques, methods and questions. The quantitative methods of the study evaluated the OLS regression methods and its assumptions, including the advantages and disadvantages. The multiple OLS regression, test for cointegration and Granger Causality were tested. This chapter also included the research design, sample design, recruitment of participants, questionnaires and data analysis and verification and validation of the data and results.

The fifth chapter examined and identified key determinants affecting the demand for electricity in Libya. This chapter discussed the process of estimation of electricity demand function in Libya for the period (1980-2010) using the method of least squares technique (OLS) (Ordinary Least Squares). Factors contributing to the econometric framework of demand function for electricity in Libya were explored. According to the model used in this study the average price of electricity and the population are significant determinants of electricity demand while the others are less.

The sixth chapter examined the effect of internal/external determinants of electricity projects in Libya. The seventh chapter provided a description of the proposed framework for electricity organisations in Libya. Chapter eight included a discussion of the results and presenting the limitations of the study. The chapter provided practical recommendations that can be adopted by the government and energy firms.

8.1 RESEARCH FINDINGS AND CONCLUSIONS

The most crucial factor that helps to resolve the greatest issues of an economy is resource allocation. It is believed that competitive market forces in an economy help to maximise the net social welfare. It is true that adequate social welfare can be attained in an economy only if the demand and supply for all the goods and services traded in the market are at the equilibrium. Thus, if the demand for electricity services in the market of Libya is sustained with sufficient supply, then it is obvious that its economy would move towards equilibrium or further growth. The total electricity production in Libya has almost doubled from 2000 to 2010. However, the fast growth rate of the country has significantly increased the demand for power that has now turned out as more than the quantity supplied. The supply of electricity of the country has proved to be less than its accumulated demand in the household and business sector.

The country had to compromise on the production of oil in some of its fields due to the lack of required electricity supply. However, it has been found that the demand for electricity in a nation substantially depends on its level of economic development. For example, a highly urbanised nation like, U.S., would require more electricity than a relatively less developed country such as, Greenland. Adequate electricity supply is the prerequisite for social and economic satisfaction in a nation. Thus, it is very crucial to understand the determinants that alter the supply and demand thresholds of electricity in Libya. It is noted that the level of Gross Domestic Product of the country has fallen from US $101.4 billion in 2010 to about US $78.63 billion in 2012 (CIA, 2013).

The country is still recorded to possess the highest per capita income in Africa, but the level of investment in the nation is low. Thus, the analysis of electricity demand in Libya is indispensable. The findings from research would assist in understanding different policies that must be undertaken to meet the needs of the society. As a fact, the primary underlying driving force of an economy is the progress of the energy sector. The researcher has appropriately figured the key determinants affecting the demand for electricity in Libya after analysing the data from 1980 to 2010. It is believed that the analysis made in the study would help to understand the rising demand for electricity in Libya and carve its path for long-term economic development (Numov, 2009).

The framework of the study has helped to throw light on the energy sector of the country. The researcher has successfully analysed the significant factors that determine the demand for electricity in the market of Libya. It also explains the tracking ability of the electricity demand model with the other economic models in Libya. The impact of the external and internal factors on the electricity projects of the country was also examined.

The qualitative context of the study is written on the basis of data and information collected from authentic secondary data sources. It has provided a strong base of theoretical concepts that has considerably helped in preparing the research. The quantitative analysis in the study has helped to generate a robust idea about the research topic. The empirical analysis of Ordinary Least Square regression test of cointegration has helped to pragmatically prove the theoretical perspectives discussed here. The tracking of the electricity model of Libya with the other models of the economy has been executed accurately with the help of Granger Causality test (Joyce, 2012).

The theoretical analysis of the study was verified with the help of the quantitative methods. The relevant data for the purpose of the analysis is a time series data for time dimensions between 1980 and 2010. The multi-co-linearity test in the analysis helped to understand the presence of correlated independent variables in the data. The most statistically significant variables that were found to be responsible for causing ninety-nine per cent variations in the level of electricity demand of Libya are:

- Average real price value of electricity;
- The real value of the imported electrical appliance;
- Gross Domestic Product;
- Population of the country;
- The changes in the level of temperature; and
- The lagging value of electricity demand in Libya.

The regression analysis suggests that the real average price value of electricity in the country is inversely related to the demand for electricity, owing to the law of demand in the market. On the other hand, the factors such as, average real value of the electricity appliances, GDP and the population thresholds, are all positively related to the value of the electricity demand. A rise in the population in the country would obviously increase the level of electricity demand and the increase in the domestic income levels will also create a positive impact on the same. This is because with the rising level of domestic income in a nation, it's per person purchasing power would increase, thereby heightening the demand for electricity by the citizens there.

Electricity is a nominal good which enjoys a strong negative price effect and positive income effect. It implies that the demand for the service reduces, when its price level in the market rises as the service does not fall in the category of necessities. On the contrary, the positive income effect clearly states that the rise in the level of income would increase the demand for electricity. However, it has been found that in Libya, the income and price elasticity of electricity demand is relatively inelastic in nature. This elucidates that at present the individuals of the country are consuming large quantities of electricity, as their living standards in the market have significantly improved over time (Tucker, 2010).

The bilateral causality established in the Granger Causality test suggests that the demand for electrical appliances in the country would increase with the rise in the value of imports of the same. It is also found that the rise in the level of population has a bilateral relationship with the level of electricity demand in the country. The most significant factors that were found to affect the demand of electricity in Libya were:

- Average price of the electricity; and

- Population.

The other factors that were included in the model were found to be less effective than the above two variables.

After obtaining the results from the population regression process, the researcher discussed the results of the regression in focus group interviews. There were four focus group interviews that were conducted, each with five participants, for two hours. The independent variables included in the model were found to be relevant by all the participants of the focus group interviews. However, all of them claimed that among the independent variables, population, average price of electricity and income were the most significant factors that could influence the changes in the level of electricity demand in the country. Moreover, every participant agreed that Libya's electricity demand had been indeed soaring up significantly during the last three decades. All the participants suggested that a rise in the level of an individual income would increase their demand for electrical devices, thereby increasing the demand for electricity.

However, the participants claimed that there are three more independent factors that could affect the level of electricity demand in Libya. These were:

- Urbanisation;
- Industrialisation; and
- Literacy rates.

It was claimed by the participants that a rise in the degree of urbanisation in the last three decades is highly responsible for the increase in electricity demand in Libya.

They claimed that an increase in the level of industrialisation in Libya is also responsible for the soaring demand for electricity. According to Burns (1997), the industries employ heavy machinery production processes that require a lot of electricity. It is obvious that a rise in the level of literacy would generate a skilled professional workforce. Rising skills of the individuals would increase their income and also, the demand for electricity.

However, in the four sessions of the focus group interviews, it was noted that the rise in the level of electricity demand in the market of Libya may have occurred due to the increase in the level of advertisements for the electrical appliances. The aggregate spending of the corporate companies on the various types of advertisement and promotional factors has increased. This has attracted the individuals of the country to create higher demand for various types of electrical appliances. Thus, the quantitative findings indicate that the average rise in price of electricity and population are the two factors that influence the demand for electricity in Libya.

In order to understand the impact of internal and external environment on the electricity projects in Libya (supply side), the researcher conducted ten interviews in the General Electricity Company of Libya (GECOL). The main problems estimated regarding the electricity projects of the country were:

- The land area of the country is large compared to the population and a large proportion of individuals of the nation stay in the scattered rural areas. A huge number of projects are required to be constructed for satisfying the demand for the entire rural population; and

- The government did not apply any regularly mechanism to control or sustain the demand for electricity in the country.

On the basis of the interview analysis, it was claimed that the internal determinants for electricity projects in the country were political effects and electricity demand. On the other hand, the external factors that affected the construction of the required electricity projects were recession, development of other infrastructure and oil prices. The questionnaire results showed that the development of other infrastructure was the most effective factor of the external determinants on the electricity projects in Libya. Moreover, the deregulation of the economy at the beginning of the nineties led to the development of the commercial sector, this means an increase in demand for electricity. However, the political turmoil in the country was responsible for making the nation unattractive to investors. It was found that the soaring oil prices in the market weakened the long-term construction plans of electricity projects. As observed from the reviewed literature the recessionary traces in the global economy have made the financial resources scarce in the country for investments to be made in the electricity projects (EIA, 2013).

The main outcome of the validation was that the proposed framework was found practical and provided a methodology for solutions that can be taken up by the electricity sector and the government to adopt regular mechanisms to deal with the consistent upsurge in the demand and provide the basis for stable supply of electricity. The participants stressed that the framework and its components were clearly understood and with a number of conditions and initiatives are conducive to provide the basis for stable supply of electricity to the citizens and their businesses. It was further suggested that the framework will provide the basis for projection of future electricity demand in Libya. The findings from the framework have confirmed that the general electricity company in Libya and the Libyan government should incorporate the actions proposed in the framework.. The key actions include:

- Economic planning;
- Socio-economic development policy;
- Development of new power plants and expansion of the existing capacity; and
- Improved development of other infrastructure.

The increased demand for electricity in Libya compels the government, the electricity company and the other sectors of the economy to come up with a sustainable framework to meet the energy demands of the country. While the company have the option of expanding the productivity of the current facilities to meet the electricity demands, it is only a short-term mitigation measure which cannot meet the expected demand. Building new power projects is the only long-term solution that will address the present and future energy needs in Libya.

8.2 LIMITATIONS OF THE STUDY

A number of caveats need to be noted regarding the present study. Due to limitations in time, cost, political instability in the country and the lack of security, the entire analysis was only of the demand for electricity in Libya based on data collected from secondary sources and primary data resources. The ordinary least square method of regression used for the purpose of quantitative analysis, only included the factors related to the demand for electricity in Libya. It is worth noting that the research work did not include any quantitative analysis that comprised of factors related to the supply of electricity in the country. Such an analysis could have technically carved the ways to augment the supply of electricity. Therefore, the context of the research work is one-sided that focuses primarily on the demand. Moreover, the inferred result from the context of the study would be more robust if the researcher could have conducted more focus groups and interviews.

It is worth noting that, the study used quantitative and qualitative methods to accomplish the main aim of the study, the econometric research approach aimed at exploring how and in what magnitude that price, income level, population, appliance imports, and temperature affects the demand for electricity in Libya, then the qualitative approach was used in the verification of the results of the econometric model.

However, this research experienced major limitations that were potential to challenging the reliability of the research findings. One of the major limitations was the use of a single approach to facilitate data collection and analysis to achieve the other objectives in the context of this study, the use of a qualitative research approach only was a major limitation.

As observed by Creswell (2003), studies that use a mixed methodology research are more reliable because they engage triangulation. Triangulation in this case is a comparison of research findings from two different approaches as used in data collection relating to an identified phenomenon. The use of a qualitative research approach only allowed for the presentation of research findings from a single perspective.

Another major limitation in a part of this study was the use of questionnaires in data collection. As noted by Creswell (2009), questionnaires are not appropriate in studies that require in-depth evaluation and explanation of a research phenomenon. The questionnaire method is more appropriate in studies that require a comparison and evaluation of relationships between the identified research variables. In this research, there was no need to develop a relationship between variables. The research approach aimed at exploring the effect of internal and external determinants of electricity projects in Libya. This was therefore a more explorative than descriptive study which is why the use of a questionnaire limited the in-depth evaluation of the phenomenon that has been examined.

Another limitation is that the study is also dependent on a small sample to collect data on the identified phenomenon. By using a census of 30 which includes head managers, managers, technicians, engineers, technicians and other staff members to collect data, the sample size was a major limitation. Given that the staff members of Libyan electricity company is composed of 37,092 employees (GECOL, 2010), and the supply electricity is a huge portion of these workers, taking into account only 30 representatives to provide data for this study was a major limitation. This is because the number 30 is not representative enough of the electricity across Libya.

Conversely, the use of simple random sampling was also a limitation for this study. As noted by Creswell (2003), simple random sampling makes the assumption that everyone within the population has the knowledge of the research phenomenon. However, this research required individuals who only had knowledge about electricity in Libya. By using simple random sampling, the probability was that some participants could not have adequate knowledge of the phenomenon and thus were not qualified enough to provide reliable data, which meant that the data used from the sample representatives was limited.

Finally, a major limitation of the study was on the applicability of the research findings in other contexts. Given that the use and demand of electricity may vary from one region to another, the applicability of these findings to understand the limit the use of the applied knowledge in other contexts.

A major issue of this research was coined around how to choose the participants the researcher experienced when facilitating the study. It is evident that to access the 30 respondents for data collection was not an easy task. The use of interviews made it more complicated in facilitating and undertaking the study. It would have been more appropriate to use phone interviews in order to support a high level of convenience in data collection.

The data collected would not be highly reliable because these were only representatives from the company. In fact, a level of bias was experienced in the data collected because of the employees' sensitivity toward the topic. The employees' commitment to the company's success blurred their objectivity to provide reliable data. Instead, a preference for engaging the Libyan population, who are the consumers of electricity, would have been a better option. This way, the different perspectives on electricity demand in Libya would have been achieved. Additionally, the inclusion of another category of respondents would have been more appropriate because a larger sample would have been achieved. As noted among the limitations of the study, the small size of the sample challenged the reliability of the findings. Therefore, the need to include a larger and more representative sample was observed from the current study.

8.3 CONTRIBUTIONS TO RESEARCH

Along with the various practical implications, the research work has contributed a lot to the context of the existing literature. The study has helped to understand the precise nature of the energy sector in Libya. The holistic analysis of the study has helped to carve the strategic ways through which the growing demand for electricity in Libya can be sustained. The quantitative part of the study encouraged the method of choice in selecting the members for the interviews.

The research helps to analyse the importance of mixed economic norms in the current era. It indirectly explains that the long run growth of a nation can only be sustained by the joint efforts of the public and the private sectors. The powers and operations of the private organisations in an economy must be scrutinised and monitored by the government of the country. Thus, for sustaining the growing demand for electricity in Libya, policy makers in Libya should focus on various ways to enhance its number of electricity projects. In addition, the findings from the study will assist policy makers in Libya devise new ways to successfully increase the number of electricity projects. It is worth noting that the context of the study opens up new ways through which a country can foster its economic development with the essence of adequate power supply.

8.4 RECOMMENDATIONS

The two most significant factors to create maximum changes in the level of electricity demand in Libya are population and price. Reducing the level of population in a country is a far more elaborate and long process. However, the peaking demand for electricity in the market of Libya can be reduced by artificially manipulating its level of prices (increasing). It should be considered that this initiative would reduce the country's overall level of social welfare. The soaring demand for electricity in the country can only be sustained with the help of adequate supply. By ignoring the internal political issues, the existing government and stakeholders should take measures to raise the number of the electricity projects in the country.

8.4.1 Recommendations to the Libyan Government

- The government should ensure that economic planning and socio-economic development policy governing the electric sector and other sectors of the economy are always the result of the systematic evaluation and combination of the specific measures that take into account the factors affecting or associated with stakeholders.

- There is the need to prioritise the construction programs (electricity projects) on the basis of benefits that can be derived from each project. It was found that a large proportion of individuals of the country live in the rural regions. The planning authorities should first execute the power generation projects that can provide services to the maximum number of individuals in the nation. Also, the country is trying to reduce its political problems. It is likely that with the economic development of a nation, the level of electricity or energy consumption would increase. At this juncture, adequate supply of electricity is the only method that can resolve the concerned issue. It should be analysed that in future, if the demand for electricity surpasses its supply for a prolonged period of time, then it would create severe upward pressure on the prices of electricity (Kumar, 2005).

- Attracting foreign direct investments for new electricity projects in the country is necessary. Many emerging economies in the world like China and Russia are found to be largely interested in investing money in business segments of other economies. Libya should try to attract foreign investments from such nations to finance its power generation projects in its economy. Also, the government of Libya must try to enhance its level of domestic and foreign investments for electricity projects. Efficient allocation of the resources is a method which would increase the electricity supply in the country in future.

- The government should also try to improve the infrastructural facilities in the country for the future as an improvement in its infrastructure would facilitate the construction of new and effective electricity projects.

8.4.2 Recommendations to the national General Electric Company of Libya

- Allocating the required project resources efficiently is needed. The company should try to allocate labour, technology, capital and entrepreneurship resources efficiently while planning its electricity projects. This is the way in which the cost of operations of such projects would be increased and productivity from such projects would be enhanced.

- The General Electric Company should disseminate the culture of rationalising the use of electricity and providing users of the electricity with information and procedures that help in the rationalisation of the use.

- An effort can be undertaken by the electricity company to enhance its renewable sources for energy in the market.

Electricity in Libya should be generated from a diversified mix of sources. EIA estimates that Libya consumed almost 0.9 quadrillion British thermal units (Btu) of energy in 2010, of which more than 70 per cent was from consumption of petroleum and petroleum products and almost all of the remainder was from natural gas. According to Saleh (2006), Libya has a large potential for production of renewable sources of energy, solar energy being one of them. Saleh (2006) noted that the country has potential to produce four times the amount of energy they produce using oil resources. As suggested by Saleh (1993), they need only 0.1 per cent of their landmass for solar energy, the country receives average sun duration of more than 3500 hours per year which shows the country's potential for solar energy production. In addition, the potential for wind energy, the average wind speed within the country at a 40 meter height is between 6- 7.5 m/s. That is enough wind power for electricity generation. Several locations, including a number along the coast, experience high wind speeds which last for long periods of time. If this wind energy could be harnessed not only could Libya meet its own demands for energy, but also a significant part of the world's demands by exporting the electricity generated (Mills, 2008).

Also the geothermal energy is another small-scale growth area, but one which shows much promise. If new housing is built in such a way that it is not dependant on air-conditioners for cooling then this would greatly reduce electricity consumption. This type of system has already been built and found extremely successful in Palestine, reducing home energy usage by as much as 70 per cent. The University of Madaba in For instance, Jordan is currently building the largest geothermal energy system in the Middle East, which will save 130,000 litres of diesel fuel per year (Helpman, 1998). It is a worthwhile recommendation from this study that will go a long way in helping boost electricity production (Helpman, 1998).

8.4.3 Recommendations to other sectors of the economy

- To meet the requirements of growth and expansion in economic sectors, the future needs of the electric power required by the new projects in these economic sectors should be considered before starting the implementation of new projects.

- Other sectors should use a selection of contemporary construction methods that will lead to energy saving.

8.4.4 RECOMMENDATIONS FOR FUTURE RESEARCH

This study has achieved its aim and its objectives and the results and observations obtained from this research could be used as a base for further research. Several issues were raised. Some of these have been analysed and incorporated into the thesis. Others, however, could not be incorporated due to the study scope, time as well as other constraints. Certain aspects that were not covered in-depth have been recommended for further work that could be pursued. It is recommended that further work research be undertaken in the following areas:

- This current study used a macroeconomic theory approach to examine and identify key determinants affecting the demand for electricity in the whole Libyan economy and there will be the need for further research to examine and identify key determinants affecting the electricity demand for each sector in the economy separately by using a microeconomic theory approach to provide further insight on the effect of sector-specific factors on electricity demand.

- Future studies should expand the research by concentrating on the inclusion of more detailed variables, such as urbanisation, industrialisation and literacy rates, which have been implicitly mentioned but not overtly examined during the research, in relation to particular origins using both quantitative and qualitative research approaches.

- The structure of the proposed framework and its major components basically utilised the opinions and attitudes of experienced personnel. There is a need for further research in identifying the relationship among these components, the impact of such relations on overall general electric company performance and possibly the introduction of additional components.

- The findings of the study reported that increasing the price of electricity is not the most effective tool to reduce electricity consumption in the Libyan economy. Therefore, future research should focus on proposing a framework for the General Electric Company of Libya on the possibility of implementing procedures that helps in the rationalisation of the use of electricity.

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APPENDICES

Appendix A: Evolution of gross domestic product GDP in the economic sectors at current prices during the period (1962-2010) in Libyan Dinar million

Year	The oil and gas sector	Agriculture sector	Industry sector	Other sectors	GDP
1962	38.0	14.9	9.6	93.9	155.5
1963	99.6	15.1	10.6	110	235.3
1964	195.7	16.7	12.3	139.9	364.6
1965	270.1	25.2	13.6	183.2	492.1
1966	356.1	27.3	15.5	236.0	634.9
1967	402.5	30.9	17.7	296.7	747.8
1968	648.6	33.4	21.5	369.1	1072.6
1969	754.7	37.4	22.3	408.6	1223.0
1970	812.6	33.1	24.2	418.4	1288.3
1971	922.7	33.0	32.1	598.7	1586.5
1972	920.6	43.6	41.4	747.4	1753.0
1973	1131.8	60.0	55.8	934.9	2182.5
1974	2385.3	64.7	70.5	1275.2	3795.7
1975	1961.1	82.9	86.2	1544.1	3674.3
1976	2750.0	99.7	114.8	1803.6	4768.1
1977	3275.9	90.0	153.2	2093.6	5612.7
1978	2808.7	122.1	182.0	2383.2	5496.1
1979	4545.3	140.4	227.3	2690	7603.0
1980	6525.7	236.4	259.1	3532.6	10553.8
1981	4403.3	273.6	303.1	3818.8	8798.8
1982	4235.8	285.7	326.7	4084.2	8932.4
1983	3823.6	303.0	392.9	3992.2	8511.7
1984	3209.8	323.0	414.7	3857.2	7804.7
1985	3500.4	342.2	471.3	3538.2	7852.1
1986	2595.8	384.7	417.7	3562.5	6960.7
1987	1875.4	411.2	403.2	3321.8	6011.6
1988	1570.0	423.3	482.1	3710.6	6186.0
1989	2055.0	439.8	514.6	4181.6	7191.0
1990	3243.8	482.9	563.1	3957.1	8246.9

Continued Appendix A

Year	The oil and gas sector	Agriculture sector	Industry sector	Other sectors	GDP
1991	3104.3	542.4	587.5	4523.1	8757.3
1992	2925.7	630.2	680.4	4995.6	9231.9
1993	2460.1	708.8	842.7	5126.1	9137.7
1994	2892.9	827.9	741.5	5208.5	9670.8
1995	3380.0	933.4	876.0	5482.9	10672.3
1996	3960.3	1074.5	890.4	6402.1	12327.3
1997	4505.8	1267.0	1015.5	7012.2	13800.5
1998	2786.0	1394.3	977.5	7452.8	12610.6
1999	3995.9	1449.9	1086.4	7543.0	14075.2
2000	7080.6	1437.7	1183.6	8073.5	17775.4
2001	6345.8	1392.0	1184.5	8718.4	17640.7
2002	13164.2	1348.8	1177.5	9290.7	24981.2
2003	21514.4	1333	1991.9	12521.4	37360.7
2004	29202.1	1328.6	2451.8	15176.5	48159.0
2005	44041.7	1447.5	3124.8	18004.6	66618.6
2006	53867.8	1643.1	3602.6	5128.5	79029.9
2007	62282.6	1905.3	4032.1	24473.6	92693.6
2008	81149.8	2247.9	4888.8	28353.1	116639.6
2009	47087.1	2382.7	5447.6	31371.5	86288.9
2010	55501.9	2644.9	5877.1	35928.7	99952.6

Source:

1. The Secretariat of the General People's Committee for Planning. (1997). Economic and Social Indicators 1962-1996.
2. General Planning Council. (2000). National Accounts 1986-1999 and Estimates for 2000.
3. Central Bank of Libya. (2003). Economic Bulletin. Volume 43, Table 22.

Appendix B: Implicit deflator of GDP in different sectors during the period 1962-2010.

Year	The oil and gas sector	Agriculture sector	Industry sector	GDP
1962	0.049	0.081	0.277	0.077
1963	0.056	0.082	0.288	0.067
1964	0.061	0.094	0.308	0.062
1965	0.063	0.103	0.315	0.064
1966	0.068	0.116	0.322	0.069
1967	0.071	0.125	0.322	0.073
1968	0.077	0.142	0.325	0.073
1969	0.074	0.155	0.331	0.069
1970	0.075	0.180	0.338	0.070
1971	0.103	0.154	0.352	0.099
1972	0.116	0.162	0.355	0.116
1973	0.180	0.170	0.416	0.171
1974	0.465	0.169	0.555	0.367
1975	0.491	0.200	0.589	0.388
1976	0.529	0.211	0.605	0.409
1977	0.594	0.228	0.605	0.452
1978	0.525	0.285	0.619	0.424
1979	0.790	0.308	0.805	0.583
1980	1.320	0.314	0.717	0.889
1981	1.465	0.318	0.734	0.976
1982	1.333	0.325	0.744	0.911
1983	1.280	0.328	0.724	0.889
1984	1.122	0.346	0.724	0.829
1985	1.056	0.364	0.703	0.794
1986	0.697	0.367	0.802	0.612
1987	0.644	0.387	0.663	0.620
1988	0.522	0.394	0.660	0.593
1989	0.608	0.404	0.696	0.643
1990	0.799	0.425	0.702	0.711

Continued Appendix B

Year	The oil and gas sector	Agriculture sector	Industry sector	GDP
1991	0.629	0.479	0.700	0.687
1992	0.631	0.524	0.758	0.731
1993	0.573	0.616	0.827	0.704
1994	0.645	0.716	0.887	0.745
1995	0.757	0.794	0.967	0.814
1996	0.877	0.904	0.929	0.905
1997	1.000	1.000	1.000	1.000
1998	0.617	1.094	0.968	0.910
1999	0.913	1.172	1.034	1.014
2000	1.664	1.128	1.128	1.232
2001	1.501	1.047	1.177	1.210
2002	3.132	0.994	1.118	1.657
2003	3.822	0.994	1.107	1.964
2004	5.204	1.020	1.118	2.437
2005	7.303	1.074	1.151	3.118
2006	8.477	0.990	1.692	3.334
2007	9.713	1.103	1.758	3.724
2008	12.713	1.271	2.168	4.562
2009	7.992	1.315	2.334	3.401
2010	9.713	1.315	1.758	3.733

Source:

1. Fayyad, M., (1991). Estimating the production function in the manufacturing sector in Libya. Libya: Faculty of Economics University Garyounis. unpublished Master.
2. General Planning Council. (2001). National Accounts 1986-1999 and 2000 estimates. December, 2001.
3. Central Bank of Libya. (2003). Economic Bulletin. Volume 43.

Appendix C: Evolution of real Gross Domestic Product GDP during the period (1962-2002) at constant prices of 1997, Libyan Dinar Million.

Year	The oil and gas sector	Agriculture sector	Industry sector	GDP
1962	775.5	184	34.7	2019.5
1965	4287.3	244.7	43.2	7689.1
1970	10834.7	183.9	71.6	18404.3
1975	3994	414.5	146.3	9469.8
1980	4943.7	752.9	361.4	11871.5
1981	3005.7	860.4	412.9	9015.2
1982	3177.6	879.1	439.1	9805.0
1983	2987.2	923.8	542.7	9574.5
1984	2860.8	933.5	572.8	9414.6
1985	3314.8	940.1	670.4	9889.3
1986	3724.2	1048.2	520.8	11373.7
1987	2912.1	1062.5	608.1	9696.1
1988	3007.7	1074.4	730.5	10431.7
1989	3379.9	1088.6	739.4	11183.5
1990	4059.8	1136.2	802.1	11599
1991	4935.3	1132.4	839.3	12747.2
1992	4636.6	1202.7	897.6	12629.1
1993	4293.4	1150.6	1018.9	12979.7
1994	4485.1	1156.3	836.0	12980.9
1995	4465	1175.6	905.9	13110.9
1996	4515.7	1188.6	958.4	13621.3
1997	5505.8	1267.0	1015.5	13800.5
1998	4515.4	1274.5	1009.8	13857.8
1999	4376.7	1237.1	1050.7	13880.9
2000	4255.2	1274.6	1049.3	14451.5
2001	4227.7	1329.5	1006.4	14579.1
2002	4203.1	1357.0	1053.2	15076.2
2003	5629.1	1341.0	1799.4	19022.8
2004	5611.5	1302.5	2193.0	19761.6

Continued Appendix C

Year	The oil and gas sector	Agriculture sector	Industry sector	GDP
2005	6030.6	1347.8	4732.9	21365.8
2006	6354.6	1659.7	2129.2	23704.2
2007	6412.3	1727.4	2293.6	24890.9
2008	6383.2	1768.6	2255.0	25567.6
2009	5891.8	1811.9	2334.0	25371.6
2010	5714.2	2011.3	3343.1	26775.4

Source:

According to the schedule of enrolment data (A), (B)

Where: Real GDP = GDP at current prices / Implicit deflator of GDP.

Appendix D: Price index consumer prices in 1997 during the period (1980 - 2010)

Year	Index of consumer prices
1980	0.297
1981	0.308
1982	0.345
1983	0.381
1984	0.429
1985	0.468
1986	0.663
1987	0.747
1988	0.759
1989	0.722
1990	0.788
1991	0.744
1992	0.783
1993	0.858
1994	0.867
1995	0.967
1996	0.973
1997	1.000
1998	1.262
1999	1.355
2000	1.101
2001	1.004
2002	0.905
2003	0.886
2004	0.898
2005	0.921
2006	0.935
2007	0.992
2008	1.096
2009	1.222
2010	1.149

Source:

1. Altarhuni, A. (2002). Determinants of employment in the manufacturing sector Libya: An Empirical Study of the period (1970 - 2000). Economic Development Conference in Libya - the past and the future. Tripoli - Libya: The National for Scientific Research.
2. Central Bank of Libya. Economic Bulletin. First Quarter 2003. Volume 43.

Appendix E: Population (In thousands)

Year	Population
1980	3180.8
1981	3435.0
1982	3655.2
1983	3860.5
1984	3642.6
1985	3617.8
1986	3662.0
1987	3937.0
1988	4050.0
1989	4315.5
1990	4525.0
1991	4726.0
1992	4949.0
1993	5042.5
1994	4873.5
1995	4799.0
1996	5019.5
1997	5347.5
1998	5174.2
1999	5300.5
2000	5426.8
2001	5551.0
2002	5484.4
2003	6221.0
2004	6420.0
2005	6629.0
2006	6843.0
2007	7065.0
2008	7294.0
2009	7530.0
2010	7774.0

Source:

1. The Secretariat of the General People's Committee for Planning. (1997). Economic and social indicators from 1962 to 1996.
2. General Planning Council. (2001). National Accounts 1986 - 1999 and 2000 estimates.
3. Central Bank of Libya. Economic Bulletin. various issues.

Appendix F: Evolution of the difference between the average annual maximum temperature and minimum (D) during the period (1980 - 2010)

Year	**D**
1980	11.2
1981	16.1
1982	13.5
1983	14.0
1984	13.5
1985	14.5
1986	11.3
1987	14.2
1988	13.5
1989	16.1
1990	14.2
1991	14.2
1992	11.1
1993	12.1
1994	11.2
1995	13.2
1996	11.3
1997	11.2
1998	13.2
1999	13.2
2000	14.2
2001	16.1
2002	16.2
2003	13.1
2004	12.5
2005	13.0
2006	11.5
2007	12.5
2008	13.5
2009	12.5
2010	10.5

Source: Meteorological station / Tripoli airport.

Appendix G: Quantity Electricity demand (Giga Watt-Hour) (GWh)

Year	Electricity demand
1979	3904
1980	4577
1981	6356
1982	5864
1983	6653
1984	6753
1985	7522
1986	7011
1987	7704
1988	8161
1989	8980
1990	9851
1991	10780
1992	10798
1993	11374
1994	11551
1995	11857
1996	12086
1997	12620
1998	13528
1999	14407
2000	15496
2001	16111
2002	17531
2003	18943
2004	20202
2005	22450
2006	23992
2007	25415
2008	28666
2009	30337
2010	32558

Source: General Electric Company of Libya. Annual Report. various issues. unpublished.

Appendix H: Electricity Prices in Dinar/ Kilowatt during the period 1980-2010 in Libyan dirham/Kilowatt (for various uses).

year	1980-1983	1984-1995	1996	1997	1998	1999-2010
Household	10	20	20	20	20	20
Young Agricultural	15	15	20	25	30	30
Senior Agricultural	15	15	21	27	32	32
Industrial Light	15	15	24	33	42	42
Heavy Industrial	10	10	17	24	31	31
Commercial	20	30	36	46	48	48
Public Facilities	20	30	36	42	47	47
Street Lighting	20	30	35	40	45	45

Source: General Electric Company of Libya. Consumer accounts administration.

Appendix I: Average Electricity Price in Libyan

Year	*Average Electricity Price in Libyan dirham/Kilowatt	**Real Average Electricity Price in Libyan dirham/Kilowatt	Real Average Electricity Price (P) in Libyan Dinar / Kilowatt
1980	15.625	52.6	0.0526
1981	15.625	50.7	0.0507
1982	15.625	45.3	0.0453
1983	15.625	41.0	0.0410
1984	20.625	48.1	0.0481
1985	20.625	44.1	0.0441
1986	20.625	31.1	0.0311
1987	20.625	27.6	0.0276
1988	20.625	27.2	0.0272
1989	20.625	28.6	0.0286
1990	20.625	26.2	0.0262
1991	20.625	27.7	0.0277
1992	20.625	26.3	0.0263
1993	20.625	24.0	0.0240
1994	20.625	23.8	0.0238
1995	20.625	21.3	0.0213
1996	26.125	26.8	0.0268
1997	32.125	32.1	0.0321
1998	36.875	29.2	0.0292
1999	36.875	27.2	0.0272
2000	36.875	33.5	0.0335
2001	36.875	36.7	0.0367
2002	36.875	40.7	0.0407
2003	36.875	41.6	0.0416
2004	36.875	41.1	0.0411
2005	36.875	40.0	0.0400
2006	36.875	39.4	0.0394
2007	36.875	37.2	0.0372
2008	36.875	34.5	0.0345
2009	36.875	30.2	0.0302
2010	36.875	32.1	0.0321

Where

* Calculated from the data in Appendix H.

** Calculated by dividing average electricity price on price index from Appendix D.

Appendix J: Value of imported electrical appliances in Million Libyan Dinars

Year	Value of imported electrical appliances	*Real value of imported electrical appliances
1980	219.3	738.3
1981	271.4	881.2
1982	221.6	642.3
1983	173.9	456.4
1984	196.5	458.0
1985	166.1	354.9
1986	171.2	257.9
1987	150.6	201.6
1988	219.8	289.6
1989	167.3	231.3
1990	173.7	220.4
1991	149.4	200.8
1992	146.4	187.0
1993	168.0	195.8
1994	137.0	158.0
1995	136.1	140.7
1996	187.3	192.5
1997	218.9	219.9
1998	176.1	139.5
1999	177.9	131.3
2000	200.9	182.5
2001	287.3	286.2
2002	612.5	676.8
2003	875.8	988.5
2004	1042.2	1160.6
2005	1250.6	1357.9
2006	1447.7	1548.3
2007	1231.7	1241.6
2008	1951.1	1780.2
2009	2324.2	1902.0
2010	2607.7	2269.5

Source:

1. The Secretariat of the General People's Committee for Planning. (1997). Economic and Social Indicators 1962-1996. p 53.
2. The National Commission for Information and Documentation. Statistical Yearbook. various years.
3. The National Commission for Information and Documentation. Foreign trade statistics. various years.
4. Trade Competitiveness Map. Analyse country and product competitiveness with trade flows. Available at: http://legacy.intracen.org/appli1/TradeCom/TP_IP_IC.aspx?IN=85&YR=2009&IL=85%20%20Electrical,%20electronic%20equipment
5. *Real value of imported electrical appliances calculated by dividing value of imported electrical appliances on Price index from Appendix D.

APPENDIX K: QUESTIONNAIRES

The questionnaire is designed to achieve particular research objectives, my wish that you give answers to the questionnaire. Answer by selecting one choice or giving your opinion where possible. Remember that both your identity and your functional specialisation in the company will remain strictly confidential.

Date ……………………………………………………………………..……………

Academic qualification ……………………………………………………………….

Experience in this field ……………………………………………………………….

Functional specialization in the company………………………...……..…………….

The period that you have worked within this company ………………………………

Questionnaires

1- There have been enough electricity projects in Libya over the period (1980-2010). Please indicate to what extent you agree or disagree with the following definition, by circling (O) the appropriate character.

A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

2- Do you agree that the electricity projects in Libya faced a problem in development and construction of new projects?

A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

3- Is it true that there has been a consistent upsurge in the demand for electricity in Libya over the period (1980-2010)?

A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

4- Do you agree that the government of Libya has adopted regular mechanisms to deal with the consistent upsurge in the demand?

A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

5- Do you agree that the government of Libya has done enough electricity projects to meet the demand?

A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

6- Is it true that the presence of companies constructing different electricity projects in the country will help meet the demand?

A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

7- In your view, what is your opinion about the subject of the previous questions

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

8- The following is a list of main internal factors that cause an increase in the number of electricity projects under construction. Please indicate (i.e. tick (√)) the extent of the level of importance on each factor using a scale from A to F where: A indicates 'very important-VI'; B 'important-I'; C 'fairly important-FI'; D 'slightly important-SI 'and F 'not important-NI'.

Internal factors	VI	I	FI	SI	NI	From the list please select 3 most important
Demand for Electricity in Libya						
Population trends						
Income						
Appliance imports						
Temperature						
Political effect						
Electricity tariff						

9- In your view, list some of the internal determinants of electricity projects in Libya? and the extent of their importance?

……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………
…………………………………………………………………………..…………….
……………………………………………………………………………………………

10- The following is a list of main external factors that cause an increase in the number of electricity projects under construction. Please indicate (i.e. tick (√)) the extent of the level of importance on each factor using a scale from A to F where: A indicates 'very important-VI'; B 'important-I'; C 'fairly important-FI'; D 'slightly important-SI 'and F 'not important-NI'.

External factors	IV	I	FI	SI	NI	From the list please select 2 most important
Recession						
Foreign Direct Investment						
Improved development of other infrastructure						
The temperature						

11- In your view, list some of the external determinants of electricity projects in Libya? and the extent of their importance?

…………………………………………………………………………………………
…………………………………………………………………………………………

12- Do you believe low supply of electricity affects the levels of economic growth in Libya?
A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

13- Do you believe that consistent and stable electricity supply in the country can lead to improved living standards of the people?
A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

14- Do you think the situation that is seen in the country after the revolution will help stabilise the supply of electricity?
A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

15- Do you think there are enough competent professionals who can help in dealing with the issue of electricity in Libya?
A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

16- Do you agree the completion of the projects will be enough to meet all sectors demands for electricity?
A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

17- Do you believe that Libya’s lack of good leadership has been the main cause for poor electricity supply?
A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

18- Do you believe availability of funds is the main cause for low supply of electricity?
A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

End of Questionnaires

Thank you very much for taking part in this survey. If you would like a summary of the results, please enter your name and contact address below.
Name:
Contact Address:

APPENDIX L: FOCUS GROUPS QUESTIONS

Date…………………………………………………………………………………
Functional specialisation in the company………………………………………….
The period that you have worked within this company ……………………………….

Questions

1. Is it true that there has been the consistent upsurge in the demand electricity in Libya over the period (1980-2010)?
   A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

2. In your view, list some of the determinants of electricity demand in Libya?

3. Do you agree that the main factors that directly affect the demand electricity are the average real price of electricity, the real value of the imported electrical appliances, GDP, population, the temperature difference and the lagged electricity demand?
   A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree
   Specify in the order of their significance;

4. How often has the government of Libya adopted mechanisms to deal with the consistent upsurge in the demand?

5. In your view what are some of the main solutions to the problem of increased electricity demand in the country?

6. What are the various options which are available to the country to help in meeting the demand for electricity in the country?

7. Do you agree that there have been enough electricity projects in Libya over the period (1980-2010)?
   A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

8. Do you agree that the electricity projects in Libya faced a problem in development and construction of new projects?
   A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

9. Is it true that the presence of companies constructing different electricity projects in the country will help meet the demand?
   A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

10. How have the low supply of electricity issues have been resolved by the company in the past?

11. What are the most common reasons for poor electricity supply experienced by the consumers? List them in the order of their frequency of occurrence

12. What can be done to improve the electricity supply?

13. In your view, list some of the internal/external determinants that affect electricity projects in Libya?

14. Do you agree that the main internal factors that directly affect electricity projects in Libya are; the demand for Electricity in Libya (Population trends, Income, Appliance imports, Temperature), Political effect and Electricity tariff?
    A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree
    Specify in the order of their significance;

15. Do you agree that the main external factors that directly affect electricity projects in Libya are; Recession, Foreign Direct Investment, Improved development of other infrastructure, temperature?
    A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree
    Specify in the order of their significance;

16. Do you believe that consistent and stable electricity supply in the country can lead to improved living standards of the people?
    A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

17. Do you think the situation that is seen in the country after the revolution will help stabilise the supply of electricity?
    A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

18. Do you think there are enough competent professionals who can help in dealing with the issue of electricity in Libya?
    A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

19. Do you agree the completion of the projects will be enough to meet all sectors demands for electricity?
    A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

20. What are your comments on the proposed framework for Electricity Organisations?
    A. Strongly agree B. Agree C. Fairly agree D. Disagree E. Strongly disagree

21. Do you find the proposed framework useful for Electricity Organisations in future industry projects?

22. What do you think about the acceptability of the proposed framework with the Electricity Organisations?

23. Any additional comments and suggestions on the proposed framework.

Please feel free to make any general comments on the questions and on the focus groups discussions below or overleaf:

APPENDIX M: RESEARCH PARTICIPANT'S RECRUITMENT LETTER FOR THE INTERVIEWS

Department of Built Environment
Liverpool John Moores University
Liverpool
Byrom Street, Liverpool, L3 3AF, UK

Contact details
Student 44 (0)7548035766 – 00218914247420 K.ELsahati@2010.ljmu.ac.uk
Supervisor 44(0)1512312859 e.g.ochieng@ljmu.ac.uk

Company Address
General electric company
Thwany Street, Tripoli, 668, Libya
gecol@gecol.ly
www.gecol.ly

Dear Sir/Madam,

I am currently undertaking a PhD entitled "Determinants of Electricity Demand in Libya, Empirical Study for the period 1980-2010". The research aims to examine and identify key determinants affecting the demand for electricity in Libya, and the main objectives for this study will include the following:

- To examine the effect of internal/external determinants of electricity projects in Libya.
- To review current practice in the Libyan energy sector and compare this to the UK.
- To identify factors contributing to an econometric framework of demand function for electricity in Libya.
- To compare the tracking ability of the demand for electricity model with the other models that can be developed for Libya.
- To assess the implications of the findings for policy and direction for future studies.
- To propose an econometric framework for electricity organisations in Libya.

I would be very grateful if you could kindly assist me in arranging the participation of your managers and engineers in this study. These are people who have professional understanding of issues to do with electricity and are either involved in policy formulation or in the construction of the projects. The questionnaire (please see attached questionnaire) should take no longer than one hour to complete and will provide vital information for my research. You are assured of confidentiality and that any identifying information will be destroyed at the data processing stage of the research. Please be assured that the identity of your managers and engineers shall remain strictly confidential.

If you decided to take part in the study, we would:

- Review the study with you: Determinants of Electricity Demand in Libya. This would be at a time that was convenient for you.
- In this study, you will be asked to answer questions about electricity demand and electricity projects in Libya

If you have any further questions or would like a discussion with me please contact me on 44 (0)7548035766 or leave a message to call you back as soon as possible.

Your assistance and co-operation in this research will be welcome and gratefully received; I hope you will be able to assist in furthering my research studies. Once again if you have any queries please do not hesitate to contact me.

Yours sincerely,

Khulod El sahati

PhD Research student

APPENDIX N: RESEARCH PARTICIPANT'S RECRUITMENT LETTER FOR THE FOCUS GROUPS

Department of Built Environment
Liverpool John Moores University
Liverpool
Byrom Street, Liverpool, L3 3AF, UK

Contact details
Student 44 (0)7548035766 – 00218914247420 K.ELsahati@2010.ljmu.ac.uk
Supervisor 44(0)1512312859 e.g.ochieng@ljmu.ac.uk

Company Address
General electric company
Thwany Street, Tripoli, 668, Libya
gecol@gecol.ly
www.gecol.ly

Dear Sir/Madam,

I am currently undertaking a PhD entitled "Determinants of Electricity Demand in Libya, Empirical Study for the period 1980-2010". The research aims to examine and identify key determinants affecting the demand for electricity in Libya, and the main objectives for this study will include the following:

- To examine the effect of internal/external determinants of electricity projects in Libya.
- To review current practice in the Libyan energy sector and compare this to the UK.
- To identify factors contributing to an econometric framework of demand function for electricity in Libya.
- To compare the tracking ability of the demand for electricity model with the other models that can be developed for Libya.
- To assess the implications of the findings for policy and direction for future studies.
- To propose an econometric framework for electricity organisations in Libya.

I would be very grateful if you could kindly assist me in arranging the participation of your managers and engineers in this study. These are people who have professional understanding of issues to do with electricity and are either involved in policy formulation or in the construction of the projects. The discussing (please see attached Questions for focus groups) should take no longer than two hours to discuss and will provide vital information for my research. You are assured of confidentiality and that any identifying information will be destroyed at the data processing stage of the research. Please be assured that the identity of your managers and engineers shall remain strictly confidential.

If you decided to take part in the study, we would:

- Review and discuss the study with you and four participants: Determinants of Electricity Demand in Libya. This would be at a time that was convenient for you and for the other (Will be conducted four focus groups, each group includes five participants)
- In this study, you will be asked to discuss questions about electricity demand and electricity projects in Libya

If you have any further questions or would like a discussion with me please contact me on 44 (0)7548035766 or leave a message to call you back as soon as possible.

Your assistance and co-operation in this research will be welcome and gratefully received; I hope you will be able to assist in furthering my research studies. Once again if you have any queries please do not hesitate to contact me.

Yours sincerely,

Khulod El sahati

PhD Research student

APPENDIX O: RESEARCH PARTICIPANT'S RECRUITMENT LETTER TO THE GENERAL ELECTRIC COMPANY OF LIBYA

Department of Built Environment
Liverpool John Moores University
Liverpool
Byrom Street, Liverpool, L3 3AF, UK

Company Address
General electric company
Thwany Street, Tripoli, 668, Libya
gecol@gecol.ly
www.gecol.ly

The research study is being conducted by student PhD: Khulod El sahati,
Student in School of Built Environment, Liverpool John Moores University.
Student sponsored by Ministry of Higher Education and Scientific Research of Libya.
Assistant Lecturer in Benghazi University (Garyounis University Previously)

Contact details
Student 44 (0)7548035766 – 00218914247420 K.ELsahati@2010.ljmu.ac.uk
Supervisor 44(0)1512312859 e.g.ochieng@ljmu.ac.uk

Dear Sir/Madam,

I am currently undertaking a PhD entitled "Determinants of Electricity Demand in Libya, Empirical Study for the period 1980-2010". The research aims to examine and identify key determinants affecting the demand for electricity in Libya, and the main objectives for this study will include the following:

- To examine the effect of internal/external determinants of electricity projects in Libya.
- To review current practice in the Libyan energy sector and compare this to the UK.
- To identify factors contributing to an econometric framework of demand function for electricity in Libya.
- To compare the tracking ability of the demand for electricity model with the other models that can be developed for Libya.
- To assess the implications of the findings for policy and direction for future studies.
- To propose an econometric framework for electricity organisations in Libya.

I would be very grateful if you could kindly assist me in arranging the participation of your managers and engineers in this study. These are people who have professional understanding of issues to do with electricity and are either involved in policy formulation or in the construction of the projects. You assist me will provide vital information for my research. You are assured of confidentiality and that any identifying information will be destroyed at the data processing stage of the research. Please be assured that the identity of your managers and engineers shall remain strictly confidential.
If you decided to take part in the study, we would:

- Request permission to undertake the study with your staff to review the study with them, on Determinants of Electricity Demand in Libya. I would be very grateful if you could kindly provide me a gatekeeper permission letter to enter the General Electric Company of Libya (GECOL)
- This study, needs thirty participants. Ten participants for the interviews and twenty for the focus groups.
- At the interviews, the participants will be asked to answer questions about electricity demand and electricity projects in Libya (please see attached questionnaire for the interviews), and they will get an information sheet about the study (please see attached Participant information sheet for the interviews). The questionnaire should take no longer than one hour to complete and will provide vital information for my research.
- At the focus groups. The participants will be asked to review and discuss the study with them. Questions about electricity demand and electricity projects in Libya will be given to them to discuss (please see attached Questions for focus groups), and they will get an information sheet about the study (please see attached Participant information sheet for the focus groups). The study will conduct four focus groups, each group includes five participants. In each group, the discussion should take no longer than two hours and will provide vital information for my research.

If you have any further questions or would like a discussion with me please contact me on 44 (0)7548035766 or leave a message to call you back as soon as possible.

Your assistance and co-operation in this research will be welcome and gratefully received; I hope you will be able to assist in furthering my research studies. Once again if you have any queries please do not hesitate to contact me.
Yours sincerely,
Khulod El sahati
PhD Research student

APPENDIX P: PARTICIPANT CONSENT FORM

Project title

"Determinants of Electricity Demand in Libya, Empirical Study for the period 1980-2010"

Project summary

The research aims to examine and identify key determinants affecting the demand for electricity in Libya, and the main objectives for this study will include the following:

- To examine the effect of internal/external determinants of electricity projects in Libya.
- To review current practice in the Libyan energy sector and compare this to the UK.
- To identify factors contributing to an econometric framework of demand function for electricity in Libya.
- To compare the tracking ability of the demand for electricity model with the other models that can be developed for Libya.
- To assess the implications of the findings for policy and direction for future studies.
- To propose an econometric framework for electricity organisations in Libya.

By signing below, you are agreeing that:

(1) you have read and understood the Participant Information Sheet, (2) questions about your participation in this study have been answered satisfactorily, (3) you are aware of the potential risks (if any), and (4) you are taking part in this research study voluntarily (without coercion).

Participant's Name* ……………………………………

*Participants wishing to preserve some degree of anonymity may use their initials

Participant's signature …………………………… Date ……………………

Contact me at: 00218914247420. Or 44 (0)7548035766 /Email K.ELsahati@2010.ljmu.ac.uk

Contact my work at: 00218612228825 - Department of Economics -Faculty of Economics- Benghazi University (Garyounis University Previously)

APPENDIX Q: PARTICIPANT INFORMATION SHEET FOR THE INTERVIEWS

Contact details

Student 44 (0)7548035766 – 00218914247420 K.ELsahati@2010.ljmu.ac.uk
Supervisor 44(0)1512312859 e.g.ochieng@ljmu.ac.uk

Invitation

You are being asked to take part in a research study on: Determinants of Electricity Demand in Libya, Empirical Study for the period (1980-2010)

I am providing you this sheet to let you know about a research study that you have the option to take part in. The research study is being conducted by PhD student:
Khulod El sahati,
Student in School of Built Environment, Liverpool John Moores University.
Student sponsored by Ministry of Higher Education and Scientific Research of Libya.
Assistant Lecturer in Benghazi University (Garyounis University Previously)

Taking part in research is always optional. We are looking for people who want to take part in this research study and who are: The participants mainly comprise of senior managers working in the electric sector (Libya). These are people who have professional understanding of issues to do with electricity and are either involved in policy formulation or in the construction of the projects.

Before you decide it is important that you understand why the research is being done and what it involves. Please take time to read the following information. Ask us if there is anything that is not clear or if you would like more information. Take time to decide if you want to take part or not

The purpose of the study

The research aims to examine and identify key determinants affecting the demand for electricity in Libya, and the main objectives for this study will include the following:

- To examine the effect of internal/external determinants of electricity projects in Libya.
- To review current practice in the Libyan energy sector and compare this to the UK.
- To identify factors contributing to an econometric framework of demand function for electricity in Libya.
- To compare the tracking ability of the demand for electricity model with the other models that can be developed for Libya.
- To assess the implications of the findings for policy and direction for future studies.

- To propose an econometric framework for electricity organisations in Libya

The study is an important area for research, because estimating the parameters of the demand function for electricity has a practical relevance, It will allow policy-makers or business to anticipate the need for power plants in Libya. The Libyan government will find the concern relevant because it will allow them to anticipate needs even before awareness of the needs emerges.

What will happen

If you decided to take part in the study, we would:

- Conducted an interview and review the study with you, on Determinants of Electricity Demand in Libya. This would be at a time that was convenient for you.
- In this interview, you will be asked to answer questions about electricity demand and electricity projects in Libya (please see Questionnaires attached)

Participants' Rights

- You have the right to omit or refuse to answer or respond to any question that is asked of you (as appropriate, "and without penalty").
- You may decide to stop being a part of the research study at any time without explanation. You have the right to ask that any data you have supplied to that point be withdrawn/destroyed
- There are no known benefits or risks for you in this study.
- The data we collect do not contain any personal information about you.
- Your participation in this study is voluntary.

Please do not hesitate to call me if you have any questions as you read over this material. I am happy to review any of this with you and answer any questions you may have. If you would like to speak to me, please call 44 (0)7548035766 – 00218914247420 or leave a message to call you back as soon as possible.

Thank you for your time.

Sincerely, Khulod El Sahati

APPENDIX R: PARTICIPANT INFORMATION SHEET FOR THE FOCUS GROUPS

Contact details

Student 44 (0)7548035766 – 00218914247420 K.ELsahati@2010.ljmu.ac.uk
Supervisor 44(0)1512312859 e.g.ochieng@ljmu.ac.uk

Invitation

You are being asked to take part in a research study on:
Determinants of Electricity Demand in Libya, Empirical Study for the period (1980-2010)

I am providing you this sheet to let you know about a research study that you have the option to take part in. The research study is being conducted by student PhD:
Khulod El sahati,
Student in School of Built Environment, Liverpool John Moores University.
Student sponsored by Ministry of Higher Education and Scientific Research of Libya.
Assistant Lecturer in Benghazi University (Garyounis University Previously)

Taking part in research is always optional. We are looking for people who want to take part in this research study and who are: The participants mainly comprise of senior managers working in the electric sector (Libya). These are people who have professional understanding of issues to do with electricity and are either involved in policy formulation or in the construction of the projects.

Before you decide it is important that you understand why the research is being done and what it involves. Please take time to read the following information. Ask us if there is anything that is not clear or if you would like more information. Take time to decide if you want to take part or not

The purpose of the study

The research aims to examine and identify key determinants affecting the demand for electricity in Libya, and the main objectives for this study will include the following:

- To examine the effect of internal/external determinants of electricity projects in Libya.
- To review current practice in the Libyan energy sector and compare this to the UK.
- To identify factors contributing to an econometric framework of demand function for electricity in Libya.
- To compare the tracking ability of the demand for electricity model with the other models that can be developed for Libya.

- To assess the implications of the findings for policy and direction for future studies.
- To propose an econometric framework for electricity organisations in Libya

The study is an important area for research, because estimating the parameters of the demand function for electricity has a practical relevance, It will allow policy-makers or business to anticipate the need for power plants in Libya. The Libyan government will find the concern relevant because it will allow them to anticipate needs even before awareness of the needs emerges.

What will happen

If you decided to take part in the study, we would:

- Review and discuss the study with you and four participants, on Determinants of Electricity Demand in Libya. This would be at a time that was convenient for you and for the other (Will be conducted four focus groups, each group includes five participants)
- In this study, you will be asked to discuss questions about electricity demand and electricity projects in Libya (please see Questionnaires for focus groups attached)

Participants' Rights

- You have the right to omit or refuse to answer or respond to any question that is asked of you (as appropriate, "and without penalty").
- You may decide to stop being a part of the research study at any time without explanation. You have the right to ask that any data you have supplied to that point be withdrawn/destroyed
- There are no known benefits or risks for you in this study.
- The data we collect do not contain any personal information about you.
- Your participation in this study is voluntary.

Please do not hesitate to call me if you have any questions as you read over this material. I am happy to review any of this with you and answer any questions you may have. If you would like to speak to me, please call 44 (0)7548035766 – 00218914247420 or leave a message to call you back as soon as possible.

Thank you for your time.
Sincerely,
Khulod El Sahati

APPENDIX S: DATA COLLECTED FROM THE QUESTIONNAIRE IN TABLES

First section: Profile of participants

The participants	Academic qualification	Experience in this field	Functional specialisation in the company	The period that you have worked within this company
1-A.A	PhD in management	15	Senior manager	12
2-M.A	PhD in engineering	10	Senior engineer	9
3-K.O	Masters engineering	14	Senior engineer	14
4-M.M	Masters engineering	5	Engineer	5
5-H.M	Masters management	16	Manager	16
6-S.K	Masters management	10	Manager	10
7-A.F	Masters engineering	20	Electrician professional	20
8-O.M	Bachelor engineering	12	Electrician professional	12
9-T.I	Bachelor engineering	15	Electrician professional	11
10-R.A	Bachelor engineering	19	Electrician professionals	19

Second section: The questions 1,2,3,4,5,6 and 7

Where:
The figures indicate the number of participants
SA- indicates to strongly agree; A- Agree; D- Disagree; SD- Strongly disagree.

	SA	A	D	SD
There have been enough electricity projects in Libya over the period (1980-2010)			3	7
The electricity projects in Libya faced a problem in development and construction of new projects over the period (1980-2010)	3	7		
There has been the consistent upsurge in the demand electricity in Libya over the period (1980-2010)	8	2		
The government of Libya has adopted regular mechanisms to deal with the consistent upsurge in the demand			5	5
The government of Libya has done enough electricity projects to meet the demand			6	4
It is true that the presence of companies constructing different electricity projects in the country will help meet the demand	2	4	4	

Third section: The questions 8 and 9

The following is a list of main internal factors that cause to increase the construction for the number of electricity projects.

The figures indicate the number of participants who mentioned the extent of level of importance on each factor using a scale from A to F where: A indicates ‘very important-VI’; B ‘important-I’; C ‘fairly important-FI’; D ‘slightly important-SI ‘and F ‘not important-NI’.

Internal factors	VI	I	FI	SI	NI	From the list please select 3 most important
Demand for Electricity in Libya	10					10
Population trends	9	1				10
Income	1	3	4	2		3
Appliance imports	1	3	3	3		2
Temperature	1	3	4	2		
Political effect	6	3	1			5
Electricity tariff				1	9	

Fourth section: The questions 10 and 11

The following is a list of main external factors that cause to increase the construction for the number of electricity projects. The figures indicate the number of participants who mentioned the extent of level of importance on each factor using a scale from A to F where: A indicates ‘very important-VI’; B ‘important-I’; C ‘fairly important-FI’; D ‘slightly important-SI ‘and F ‘not important-NI’.

External factors	VI	I	FI	SI	NI	From the list please select the most important
Recession				2	8	
Oil prices	1	2	3	3	1	
The development in other infrastructure	10					10

Fifth section: Question 12 to the end of the questions

Where:
The figures indicate the number of participants
SA- indicates to strongly agree; A- Agree; D- Disagree; SD- Strongly disagree.

	SA	A	D	SD
Low supply of electricity affects the levels of economic growth in Libya	2	8		
Consistent and stable electricity supply in the country can lead to improved living standards of the people	1	9		
The situation that is seen in the country after the revolution will help stabilise the supply of electricity			2	8
There are enough competent professionals who can help in dealing with the issue of electricity in Libya		3	4	3
The completion of the projects will be enough to meet all sectors demands for electricity		2	4	4
Libya’s lack of good leadership has been the main cause for poor electricity supply	6	4		
Availability of funds is the main cause for low supply of electricity		2	3	5