STRATEGIES FOR THE GENERATION OF ALTERNATIVE ELECTRICITY TO HYDROELECTRIC POWER IN KENYA

BY

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UNITED STATES INTERNATIONAL UNIVERSITY AFRICA

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ABSTRACT

The purpose of the study was to investigate the strategic management decisions taken by the Ministry of Energy and the Energy Regulation Commission on the generation of electrical energy other than the traditional hydro-electricity. The main focus was to determine the extent to which strategic decisions adopted by the Ministry of Energy had solved the energy crisis in Kenya, the challenges that they faced in the generation of electricity and the available alternatives in the generation of electricity power other than by hydro means in Kenya.

The research design that was employed by this study was descriptive in nature. A descriptive design would help provide a clear description of the various strategic decisions adopted by the government and their effectiveness as well as their success in improving the energy sector in Kenya. A 30% proportionate stratified simple random sampling technique was the method used in selecting elements from the population, comprising of four categories; MoE, ERC, KENGEN, and selected independent power producers all within Nairobi Central District. A sample population of 61 respondents was adopted. Data collection was conducted by use of questionnaires that had both closed and open ended questions. A pilot test was carried out to test the reliability of the data collection tool. In the analysis of data, inferential statistics was used. The data was coded before being keyed in SPSS for analysis. Report of these analyses was presented in form of correlation analysis, cross tabulations and regression analysis.

From the findings, it was revealed that a well-functioning and fully integrated internal market for energy is key to energy security. It was also found that moderating energy demand can reduce the country’s external energy dependency. Co-ordination of risk assessment and contingency plans was also found to reduce electricity crisis. The study also found that preventing and mitigating oil disruptions can protect energy surges. It was also found that the government ought to trigger more private investments in the energy sector. It was found that efforts should focus on developing more options of electricity supply. The study revealed the ministry should work together with other stakeholders to improve Kenya’s immediate preparedness in respect of possible disruption. The study revealed that Kenya can work with other countries in the region in improving electricity supply. From the findings on challenges of impact of natural calamities, it was found that evaporation is the highest challenge, followed by flooding, reduced water run-off
and finally siltation of dams. It was also found that political instability can lead to the destruction of renewable energy infrastructure; extreme insecurity leads to risk of breach of contract between government and investors; and policies governing investment in renewable energy are often altered by regimes in power for political gain. The study revealed that lack of supportive policies for renewable energy projects, as well as limited enforcement of the same inhibits growth in this sector. It was also found that too many agencies involved in the issuing of licenses poses a great barrier for investment in the energy sector. The study showed that oil is an energy alternative to hydroelectric power, and that the government of Kenya supports and promotes the development of wind energy. It was found that the government supports the exploration of oil reserves as an investment for future prospects.

The study recommended that the government should seek partnership with other countries to improve on its energy source. This includes partnering with other regional states such as Ethiopia to supply cheaper electricity since the country is well endowed with the facilities to do so. It also recommended that the government should put its house in order so as to attract other players in the energy producing sector. Insecurity, corruption and bureaucracy have been found to turn away investors in the energy sector. It also recommended that the industry players should focus more on the options of producing alternative energy to hydroelectricity that are commercially viable in the country at the moment.
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<th>Abbreviation</th>
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<tr>
<td>GDC</td>
<td>Geothermal Development Company</td>
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<td>GHG</td>
<td>Greenhouse Gas Emissions</td>
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<td>HEP</td>
<td>Hydro-Electric Power</td>
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<td>NCCAP</td>
<td>National Climate Change Action Plan</td>
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<td>NCCRS</td>
<td>National Climate Change Response Strategy</td>
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<td>LCPDP</td>
<td>Least Cost Power Development Plan</td>
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<td>LIC</td>
<td>Low-income Country</td>
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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

The use of hydropower has been characterised by continuous technical development and it is currently the second most used renewable energy source in the world, just behind solid biomass. In terms of electricity production, hydro power is the most important renewable energy source, both in the EU and in the World: in 2004, 90% of renewable electricity in the World was produced with hydro power (IEA, 2006). About 20% of globally supplied electricity is generated by hydropower and in some countries it provides more than 50% of the electricity supply. In Norway 99% of the electricity production is generated by hydropower and New Zealand uses hydropower for 75% of its electricity (WIVC, 2004).

Presently, at least 35,000 large dams exist in the World. The number and size of large dams have increased in recent decades, with most of them in developing countries. Most industrialised countries have either developed larger prospective sites or have excluded them from development due to environmental concerns (Bartle, 2002). An overview of different sizes of hydro power installations is shown in the table below.

There is enormous exploitable hydropower potential on the African continent, but despite this, Africa has one of the lowest hydropower utilization rates. Currently less than 7% of the potential has been harnessed. Eastern, southern, central and parts of western Africa have many permanent rivers and streams providing excellent opportunities for hydropower development (Klunne, 2007).

Kenya’s Vision 2030 is founded on three pillars of economic, social and political development. The economic pillar is aimed at improving the living standards for all Kenyans through an economic development program, through which the country is expected to achieve an average Gross Domestic Product (GDP) growth rate of 10% by the year 2030 (GoK 2007). The level of economic development determines the intensity of energy use; as economic systems in developing countries expand, so is the demand for energy to power production activities. The
Kenya Vision 2030 identifies energy as one of the key infrastructural enablers, necessary for the realization of its objectives (Rambo, 2013).

The economic development program anchored in the Vision is expected to increase demand on Kenya’s energy supply. Currently, energy shortages and supply disruptions coupled with high cost remain serious obstacles to the manufacturing sector (GoK, 2012). In liberalized markets, the cost of energy significantly influences the competitiveness of local products vis-à-vis imported goods. Consequently a high cost of energy negatively affects domestic wealth creation, balance of payments and employment creation, as consumers opt for cheaper imports (Karekezi and Kimani, 2009).

Kenya’s planning for power generation and transmission is undertaken on the basis of a 20 year rolling Least Cost Power Development Plan (LCPDP) updated on a yearly basis (last update in March 2011). According to the latest LCPDP, the country currently has a total installed electricity generation capacity of 1,424 MW and a reliable capacity of 1,397 MW under average hydrological conditions. Of the total installed capacity of 1,424 MW, hydropower accounts for about 50%, with thermal capacity accounting for 34% and geothermal capacity accounting for 13%. The remaining 3% installed capacity is provided through wind, cogeneration and isolated grid technologies. The unsuppressed peak demand currently stands at 1,146 MW. This leaves no reserve margin for reduced hydropower generation due to low hydrology or for plant outages. In fact, due to extreme drought during the last 3 to 4 years, nearly half of the hydropower generation capacity was not available (ADB, 2011). In order to meet the demand despite the unreliability of the hydropower generation capacity, the Government of Kenya is obliged to rely on providers of emergency generation capacity. This emergency capacity, while having the advantage of a relatively rapid installation time, is carbon intensive (diesel and heavy fuel), and very expensive (average cost of about USD 23 cents per kWh compared to an average retail tariff of USD 16 cents per kWh for domestic (household) customers, USD 18 cents for small industrial customers and USD 12 cents for commercial and industrial customers). Increase of deploying fossil fuel electricity solutions especially for industrial sector has also led to increase of the total national import bill (ADB, 2011).
This scenario necessitates the establishment of new projects to step-up energy supply at a lower cost and increase efficiency in energy consumption. Universal access to sustainable, affordable and clean energy is instrumental for the realization of Kenya’s Vision 2030 (Rambo, 2013).

Despite good potential for renewable energy generation in Kenya, and a rapid increase in the generating capacity over the last 10 years, there is still a significant energy supply shortage in Kenya, and the limited availability of energy is thus seen as one of the constraints to industrial development. For commercial enterprises, the high costs of energy, limited availability and poor reliability undermine competitiveness significantly. Klunne (2007) states that Kenya has the most expensive electricity in East Africa, and that while Kenyan manufacturers are paying between KSh10 and KSh15 per kilowatt hour of electricity, their competitors in China and India pay the equivalent of between KSh2.50 and KSh3.80 per kWh for the same.

This problem is exacerbated during dry periods, when Kenya’s hydropower plants – which represented nearly 50% of generation in Kenya in 2010/2011 – are unable to operate at full capacity. In a survey by the Kenyan Association of Manufacturers, firms stated that they lost between 12 and 36 hours of productive work every week due to the rationing of energy during dry periods, and that power interruptions cost them 7% of sales. Transmission losses as of 2012 cost the country approximately US$17 million per year in lost output (Laurea, 2011).

The high electricity costs have led to an increasing number of commercial enterprises seeking alternative sources of energy. For example, many enterprises rely on diesel-based back-up generators to supplement electricity access; these are very expensive and introduce considerable cost volatility due to fluctuating international crude oil prices. Utilization of diesel also contributes to GHG emissions and contradicts the low carbon development pathway set out in Kenya’s NCCRS and corresponding NCCAP. But some firms are investing in renewable energy sources in order to overcome the high cost and unreliability of traditional energy sources (Hamilton, 2007).

More than 20% of Kenya’s energy needs are currently met by imported fossil fuels, mainly oil, and demand has been growing fast. But as international oil prices are expected to rise – by 1.5-2.5% annually in real terms until 2035, according to the EIA (2012) – the competitive
advantages of moving to an energy system based on domestic renewable rather than imported fossil fuels will become ever clearer over time, especially as new and maturing technologies in renewable energy generation are resulting in rapidly falling prices. This is particularly the case given that industries in LICs tend to be more energy intensive than those in developed countries, implying that higher fossil fuel price rises will hit the competitiveness of LICs hardest (Ellis, Lemma, Mutimba, and Wanyoike, 2013).

Various state-owned institutions are responsible for the generation, transmission and distribution of power. Kenya Electricity Generating Company Limited (KenGen) is the leading electric power generation company in Kenya, producing about 80% of electricity consumed nationally, using sources such as hydro, geothermal, thermal and wind (KENGEN (2011). Kenya Power (formerly known as Kenya Power and Lighting Company) transmits, distributes and retails the electricity supply throughout Kenya. Kenya Electricity Transmission Company Limited (KETRACO) is mandated to develop transmission lines and associated substations infrastructure. A number of independent power producers (IPPs) also supply bulk electricity to Kenya Power. Currently, the base load generation source for electricity is hydro and, increasingly, geothermal. However, the adverse impacts of climate change and climate variability have made hydro generation unreliable and volatile. Kenya’s reliance on such a climate sensitive resources has severe effects on the base load supply of hydropower (KPLC, 2011).

1.2 Problem Statement

Adequate power supply is an unavoidable prerequisite to any nation’s development, and electricity generation, transmission and distribution are capital-intensive activities requiring huge resources of both funds and capacity. Electricity is not only a particularly efficient and clean source of energy, but it is also, for a country like Kenya, a guarantor to the improvement of quality of life (for lighting, heating, cooking without smoke) as well as for better access of the population to essential social services such as health and education. It is also the key to development of national industries and therefore strongly impacts economic growth and employment (Barbier, 2010). In the prevailing circumstances in Kenya where funds availability is progressively dwindling, creative and innovative solutions are necessary to address the power supply problem (Sambo, Garba, Zarma, and Gaji, 2012).
A report by Barbier, (2010) found out three major problems facing Kenya’s energy sector. First there is insufficient production of electricity which leads to consumers experiencing frequent power interruptions. With less than 20% of the Kenyan population connected to the national electric grid (8% in rural settings) and the high cost of electricity, access to electricity remains a luxury in Kenya. Second, the report reveals that Kenya largely depends on hydro production of electricity which is sometimes unstable. On this, the report notes that Kenya is highly impacted by two factors on which she has very little influence: the rain gauge and the price of petrol. Third, Barbier, (2010) found out that electricity user price in Kenya which comprises the cost of fuel - is one of the highest in Africa, with an average price of 15Khs per k/Wh. The strong recourse in the past few years to electricity production, combined with the reforms on the tariff grid which allowed the electricity distributor KPLC to directly pass on the variations of the cost of fuel and exchange rates to the consumers has greatly affected consumers.

Kenya’s 1,690 MW installed electricity generation capacity is not sufficient for projected economic growth, while access to water for irrigation and industry remains low (ADB, 2014). Kenya’s power tariff remains comparatively high at USc 18.7/kw (Ethiopia USc 3/kw, Tanzania USc 9/kw). In 2012, 18% of the population had access to electricity in Kenya, compared to 14.8% in Tanzania and 23% in Ethiopia. With over 80% of power generation coming from hydro and thermal, electricity supply is vulnerable to climate variations and fuel price fluctuations. (EARC 2013)

In order to improve electricity security and avoid further black-outs, there is a need to manage demand and supply through, respectively, demand side management strategies and electricity capacity expansion. This study focuses on this issue by trying to underscore the need to come up with effective and viable decisions that would offer practical solutions. Importantly, this study examines alternative avenues that Kenya can follow to bridge the gap brought by unreliable power supplies as a result of over dependence on hydro production of electricity.
1.3 Purpose of the Study

The purpose of the study is to investigate the strategic management decisions adopted by the Ministry of Energy in the generation of electrical energy other than the traditional hydro-electricity.

1.4 Research Questions

To achieve the objectives of the study, the following research questions were used:

1.4.1 To what extent has the strategic decisions by Ministry of Energy solved the energy crisis in Kenya?
1.4.2 What are the challenges that Ministry of Energy face in the generation of electricity?
1.4.3 What alternatives does Ministry of Energy have in the generation of alternatives electricity to hydroelectric power in Kenya?

1.5 Significance of the Study

Energy is a key component in the running of an economy. It is therefore necessary for the relevant authorities in a country to ensure that there is sufficient non-interrupted supply, as required by the national grid. This study is particularly important to several stakeholders in Kenya.

1.5.1 Ministry of Energy and the Energy Regulation Commission

The ministry of energy is going to use this study to make and execute policies that will enhance sufficient energy supply.

1.5.2 Investors

Investors are going to use this research to venture into other alternative energy sources. This will make them diversify their portfolio as well as enhance energy supply.
1.5.3 Energy Generating Companies

This study will help the energy generating companies to develop effective alternatives energy sources. This will enhance energy supplies in the country.

1.5.4 Researchers and Academicians

The study will be useful to the academicians who may want to broaden their understanding on the strategic decisions in the energy industry. It will also be useful to researchers, as it will pave way for further research. Hence, the research will add to the existing body of knowledge on strategic management.

1.6 Scope of the Study

Basis of this study is on all types of electricity generating resources available presently in Kenya and future possibilities in the investment of new technologies. The study focuses on stakeholders and power generating and transmission companies who have offices within Nairobi central district. It will seek to collect views from staff from the M.o.E who also fall in the policy makers category with a view of understanding how strategic decisions have been used to make progress in investing on alternative energy resources to hydro-electric power. Further, the study would also seek to harness views from the technological experts who are the key drivers in the generation of power in Kenya. To cover all these, the study is projected to take place between the months of November and December the year 2014.

1.7 Definition of Terms

1.7.1 Renewable Energy Resources

Renewable energy is generally defined as energy that comes from resources which are naturally replenished on a human timescale such as sunlight, wind, rain, tides, waves and geothermal heat.

1.7.2 Energy Conservation

Energy conservation refers to reducing energy consumption through using less of an energy service (Charles, 2011).
1.7.3 Electricity Capacity

The net capacity factor of a power plant is the ratio of its actual output over a period of time, to its potential output if it were possible for it to operate at full nameplate capacity indefinitely (Gaul & Schröder, 2011).

1.7.4 Energy Efficiency

Energy efficiency is a way of managing and restraining the growth in energy consumption. Something is more energy efficient if it delivers more services for the same energy input, or the same services for less energy input (Karani, 2009).

1.8 Chapter Summary

The background of the study and the research questions have been clearly stated in chapter one. This study investigates the strategic management decisions adopted by the Ministry of Energy and the Energy Regulation Commission in the generation of electrical energy other than the traditional hydro-electricity.

A definition of study as well as justification for the study has also been included. It has been justified that the study will be useful to MoE and ERC, investors, general public and future researchers and will also contribute to the general body of knowledge. The next chapter is chapter two which addresses the literature review of the study. Chapter three covered extensively on research methodology, chapter four covered the analysis and chapter five had the findings, conclusions and recommendations.
CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

Chapter two is about literature review of the strategic management decisions taken by the Ministry of Energy and the Energy Regulation Commission on the generation of electrical energy other than the traditional hydro-electricity. Part 2.2 is about strategic decisions in solving energy crisis. Part 2.3 is the challenges faced during generation of hydroelectric power. Part 2.4 is the alternatives to hydroelectric power sources in Kenya. The last Part 2.5 is about the summary of the whole chapter.

2.2 The Strategic Decisions in Solving Energy Crisis

2.2.1 Increase Country’s’ Energy Capacity to Overcome Major Disruptions

In view of current events in many countries and the potential for disruption to energy supplies, short term action must focus on those countries that are dependent on one single gas supplier (Ikeme and Ebohon, 2005). The ministry of energy, for instance, should work together with, regulators, transmission systems operators and operators to improve the countries’ immediate preparedness in respect of possible disruptions. Particular attention should be paid to vulnerable areas, to enhancing storage capacity, to develop reverse flows, to developing security of supply plans at regional level and to exploit more the potential of natural energy (Wu and Chen, 2004).

2.2.2 Strengthening Emergency

For countries to ensure that they are solving energy crisis, they should enhance solidarity mechanisms. This includes coordination of risk assessments and contingency plans and protecting strategic infrastructure, (Barnes & Floor, 2009). The European Union (EU), for instance, has an overriding priority. This is to ensure that the best possible preparation and planning improve resilience to sudden disruptions in energy supplies, that strategic infrastructures are protected and that the most vulnerable Member States are collectively supported (Charles, 2011).
EU Member States, United States, and other developed nations, for instance, are obliged to build up and maintain minimum reserves of crude oil and petroleum products and this will mitigate the risks of supply disruption. Current stocks represent about 120 days of consumption which is well above minimum requirement of 90 days’ supply. Moreover, the EU stockholding obligation is consistent and linked with the oil stockholding obligation developed under the International Energy Agency (IEA). These instruments have demonstrated their relevance and efficiency. The guarantee that no physical shortage of supply is likely to occur is a fundamental element to temper market price fluctuations in the case of a crisis. The EU is therefore promoting further international cooperation and transparency concerning oil stocks and oil markets, notably involving major new consumers like China and India (Bresnahan & Ramey, 2008).

2.2.3 Preventing and Mitigating Gas Supply Disruption Risks

Since the 2006 and 2009 gas supply crises, many countries including the European countries are strengthening their coordination capabilities in order to prevent and mitigate possible gas supply disruptions. Investments in back-up infrastructure are now obligatory. This means that countries must be able to meet peak demand even in the event of a disruption of the single largest infrastructure asset. In addition, reverse flows must function on all cross border interconnections between countries or member states of trading blocks (Charles, 2011).

The EU, as an example, is better prepared for gas supply disruptions. There are European rules to secure supplies to protected customers, for example - customers that use gas for heating, in severe conditions, including in the case of infrastructure disruption under normal winter conditions. Member States need to draw up Emergency Preparedness Plans and Emergency Response Plans. The Gas Coordination Group, involving Member States, regulators and all stakeholders, has proven to be an effective EU-wide platform to exchange information between experts and coordinate action. These rules provide a European framework that creates trust and ensures solidarity as it guarantees that Member States act on their national responsibilities and collectively enhance security of supply (Alan, 2007).

According to Barnes and Floor (2009), the experience so far with respect to gas security of supply has shown that there are synergies in further cooperation across borders, for example by
developing risk assessments and security of supply plans at regional and country levels. Wu and Chen (2004) found that EU, as a trading block, has developed a regulatory framework for gas storages that recognizes their strategic importance for supply security.

Furthermore, at international level, new security of supply instruments could be envisaged with key strategic partners. Pooling a minimal part of existing security stocks in a virtual common capacity reserve – for instance under the IEA – could allow for rapid response in the case of a limited disruption (Hamilton, 2007).

2.2.4 Protection of Critical Infrastructure

The developed nations have developed a policy to address the physical protection of critical energy infrastructure against threats and hazards. Increasing attention is given to IT security. In addition, it is necessary to launch a wider debate on the protection of strategic energy infrastructure such as gas and electricity transmission systems which are providing a crucial service for all consumers. This debate should address the control of strategic infrastructure by all entities, notably by state-companies, national banks or sovereign funds from key supplier countries. This aims at penetrating the energy markets or hampering diversification rather than the development of the trading blocs’ network and infrastructure (Alan, 2007). Respect of existing EU legislation has to be guaranteed for any acquisition by non-EU buyers of strategic infrastructure. The advantages of an overall energy system that balances appropriately centralized and decentralized energy production, with the aim of building a system that is both economically efficient and resilient to outages of individual major assets should also be assessed (Wu & Chen, 2004).

According to Hamilton (2007), the existing provisions on unbundling of gas transmission activities already foresee a mechanism to ensure that transmission system operators controlled by non-EU entities comply with the same obligations as those controlled by EU entities. However, the recent experience of certain non-EU operators seeking to avoid compliance with EU legislation on EU territory might require a stricter application and a possible reinforcement of the applicable rules at EU and Member State level. In this context, the respect of EU internal market rules, notably as regards public procurement, also needs to be guaranteed.
2.2.5 Moderating Energy Demand

Moderating energy demand is one of the most effective tools to reduce the country’s external energy dependency and exposure to price hikes. The energy savings can be achieved if the measures foreseen in the relevant legislation are implemented rigorously and without delays. In particular, this applies to the EU’s Energy Efficiency Directive ("EED") and the Energy Performance of Buildings Directive ("EPBD") (Charles, 2011).

Achieving significant energy savings is only possible if there is a clear identification of priority sectors as well as mobilization of investment capital that can be easily accessed. Energy demand in the building sector, responsible for about 40% of energy consumption in the EU and a third of natural gas use could be cut by up to three quarters if the renovation of buildings is speeded up. Improvements in district heating and cooling can also make an important contribution. Likewise, industry consumes around one quarter of gas used in the EU and there is significant potential for energy efficiency gains driven by a strengthened Emissions Trading System as proposed by the Commission as part of the 2030 climate and energy framework (Alan, 2007).

In order to trigger further investment from the private sector, which has a key role to play, the European Structural and Innovation (ESI) Funds have ring-fenced a minimum of €27 billion specifically for low carbon economy investments, including energy efficiency. The current analysis of the programming of these funds by the Member States indicates that the actual amount of these investments will increase to over €36 billion. Financial instruments set up with ESI Funds contribution can leverage additional private capital investment participation, while the new business models of ESCOs (energy performance companies) can deliver savings across the energy system (Hamilton, 2007).

2.2.6 Building a Well-Functioning and Fully Integrated Internal Market

A country’s or trading bloc’s internal market for energy is a key factor in energy security and is the delivery mechanism to achieve it in a cost-effective way. Government interventions that affect this market framework, such as national decisions on renewable energy or efficiency targets, decisions to support investment in (or decommissioning of) nuclear generation, or decisions to support key infrastructure projects (such as NordStream, SouthStream, TAP or a
Baltic LNG Terminal) need to be discussed at regional level to ensure that decisions in one Member State do not undermine security of supply in another Member State. For example, various tools exist at EU level to implement such projects in respect of the acquis and in a coordinated manner (internal market legislation, TEN-E Guidelines, State-Aid control). A real European Energy Security Strategy requires that enforcement tools are preceded by a strategic discussion at EU level, not just at national level (Wu & Chen, 2004).

Positive steps have been achieved in regional market integration. Competitive and liquid markets provide an effective hedge against abuses of market or political power by individual suppliers. Well-developed trading mechanisms and liquid spot markets can offer effective short term solutions in the event of disruptions, as is already the case for oil or coal. The same security can be achieved for gas and for electricity, provided that pipeline capacity and grids are available to transmit supplies from one place to the other (Alan, 2007).

A regional approach has been and will continue to be decisive for the integration of the European energy market in terms of cross border exchanges as well as security of supply (including capacity mechanisms if necessary). The Nordic countries (Finland, Sweden, Denmark and Norway) have set the example in the electricity sector with an early integration of their markets into NordPool. Likewise, the Pentalateral Forum in the North-West (including France, Germany, Belgium, the Netherlands, Luxemburg and Austria) has initiated groundbreaking integration projects in both the electricity and the gas sector. Transmission system operators and regulators have also taken decisive steps towards the coupling of electricity markets in several areas. In gas, an achievement of similar impact is the establishment of the PRISMA-platform in 2013, where interconnection capacity for the networks of 28 TSOs responsible for transporting 70% of Europe's gas is auctioned in a transparent and uniform manner (Rambo, 2013).

Nevertheless, the development of competitive and well-integrated markets in the Baltic States and in the South East of Europe lags behind, depriving those regions of the related security of supply advantages. Targeted approaches that speed up the development of critical infrastructure as well as the establishment of regional gas hubs in these regions are needed. Proper implementation of the gas sector Network Codes will significantly improve energy security, as it will enhance open and non-discriminatory access to transmission systems so that gas can flow
freely and flexibly across the EU (Charles, 2011). In addition, antitrust and merger control rules must continue to be vigorously enforced since they ensure that EU security of supply is not weakened through anticompetitive behaviour or by anticompetitive consolidation or vertical integration of energy companies (Bresnahan & Ramey, 2008).

A truly integrated and competitive internal energy market not only needs a common regulatory framework but also significant development of energy transport infrastructure, in particular cross-border interconnections between Member States (Hamilton, 2007). For instance, the Commission estimates that some €200 billion are required up to 2020 in this respect, but that the market can currently only deliver roughly half of this (Bresnahan & Ramey, 2008).

The Regulation on the Guidelines for trans-European energy networks together with the Connecting Europe Facility (CEF) were designed to identify and ensure the timely implementation of the key projects Europe needs along 12 priority corridors and areas. The first Union list of projects of common interest (PCI) was adopted in 2013. The primary objective of EU infrastructure policy is to now ensure the timely implementation of the PCIs (Rambo, 2013). Together with the streamlined permit granting procedures, the €5.8 billion of the CEF will help to achieve this. The CEF represents only around 3% of the €200 billion investment needed up to 2020 but it can leverage other funds through using financial instruments (Wu & Chen, 2004). For the CEF to make a difference it must be targeted at few critical projects and it must also be combined with the efforts of regulators to finance part of the infrastructure through network tariffs and of Member States making use of the European Structural and Investment Funds, where relevant. Both during permitting and project implementation, due account should be taken of existing EU environmental legislation and guidance to ensure the environmental sustainability and secure public support and acceptance for the project (Bresnahan & Ramey, 2008).

2.3 Challenges in the Generation of Hydroelectric Power

The challenges facing hydropower exploitation are many and most of them are part of the larger picture of general barriers for the uptake of renewable energy and independent power producers. These generic barriers can be summarized into the lack of clear-cut policies on renewable energy
and associated requisite budgetary allocations to create an enabling environment for mobilizing resources and encouraging private sector investment. These are as follows:

2.3.1 Natural and Environmental Externalities

The environmental impacts of fossil fuels often result in real costs to society, in terms of infrastructure decay (i.e., from acid rain), declines in forests and damages directly relating to the costs associated with power generation.

2.3.1.1 Evaporation

The greatest loss of potential water resources from hydroelectric facilities comes from the evaporation of water from the surface of reservoirs. This loss of water would otherwise have been available for downstream uses as well as for the generation of electricity (Winkler, Mukheibir and Mwakasonda, 2006). Deep dams with smaller surface areas would be less affected that those with large surface areas.

2.3.1.2 Reduced Run-Off

The direct impact of drought is that the run-off is reduced and consequently the storage in dams is negatively affected. In recent years there have been some interruptions in some hydropower plants as a result of severe drought. In Zimbabwe, Kariba contributes 50% of the electricity needs, but generation dropped by 8% due to drought in 1992 (Chenje and Johnson 1996). Kenya and Tanzania were forced in 2000 to ration electricity since the hydroelectric plants has been affected by persistent drought (Ongeri 2000).

2.3.1.3 Flooding

Given that there is a predicted increase in annual rainfall and that this may be due to increased rainfall intensity and reduced rain days (Tadross et al. 2005), the occurrence of increased flooding can be expected. Unexpected flooding can be detrimental to large dams where the large loads of sediments carried by the rivers settle in the dams and lakes. For in-stream hydro plants, large logs and vegetation can cause damage or block up the system (Mukheibir 2007).
2.3.1.4 Siltation

Siltation poses another challenge in the generation of electricity (Poggiolini, 2005). It is the consequence of erosion which is prevalent in some part of Southern Africa where rains and consequently rivers can be aggressive. Non-existent or sparse vegetation and the desiccation of soils during dry seasons can make the soils particularly vulnerable to the water action. Siltation lessens the life span of dams and irrigation structures by reducing the depth of dams and hence the storage capacity. This can reduce the potential of dams to generate hydroelectricity (Winkler, Mukheibir, and Mwakasonda, 2006.)

2.3.2 Political Instability Risk

Political instability negatively influences the economic growth and social well-being of a nation (Dengerink, 2011). Political instability risk is more realistic in African countries than in any other parts of the world. Studies by AfDB, (2010); Environics, (2010) found that intra-state conflicts have been linked to the destruction of renewable energy infrastructure in Mali, Ivory Coast, Somalia and Egypt, among other countries. Furthermore, several studies have revealed a close link between political instability risk, and the level of private as well as foreign investments in the energy sector (Ramcharran, 1999). Political instability in developing countries also associates with the risk of breach of contract between governments and project financiers. In extreme cases, renewable energy projects have been expropriated. For instance, in 2010, Malian rebel groups expropriated wind farm projects in the Northern parts of the country to boost their revenues (Government of Mali, 2012; AfDB, 2010).

2.3.3 Low-Carbon Policy Risk

Low-carbon policy risk relates to the question of how credible and reliable public policies, regulation and incentives are over a period of time, and how effectively they are implemented by responsible government departments and agencies (Helm and Hepburn 2003). In many African countries, the possibility that policies and legal frameworks governing investments in renewable energy projects being altered or reversed to achieve political interests is real (UN-Energy/Africa, 2011).
In many sub-Saharan Africa (SSA) countries, the risk of low-carbon policy is largely attributed
to political instability, lack of supportive policies for renewable energy projects, as well as
limited enforcement of necessary regulations (UNEP, 2012). A study by Thomas and Munson,
(2009) in the USA, revels that some states have burnt private electric wires that cross any public
property. Lacking state or national mandates to purchase clean or more efficient energy at full
value, such legal prohibitions allow distribution monopolies to kill on-site generation. Local
energy developers, in fact, are forced to sell power to their competitor at a low price.

Electricity generation at medium- to large-scale requires a number of legal and regulatory
prerequisites by different government departments/stakeholders and authorities. The
consequence is that there are too many agencies that are involved and it takes a long time to
approve and issue licenses such as the environmental impact assessment licenses and generation
licenses (Amigun, Brent, and Musango, 2011). The regulatory requirements by the different
government departments are also uncoordinated. This implies that the electricity generation
developers may be required to submit similar information and documents to the different
departments or agencies. All these institutional and regulatory barriers have been cited by the
developers as one of the largest hurdles in deploying renewable energy (Fakir and Nicol, 2008).

Regulation and control of energy sector could have far more reaching controls. Individual home
or commercial systems connected to utility grids can face burdensome, inconsistent, or unclear
utility interconnection requirements. Lack of uniform requirements can add to transaction costs.

Kirkpatrick and Parker, (2005) notes that renewable energy policies and regulations need to be
strengthened by establishing regulatory agencies that are independent from the central
government to avoid political interference
2.3.4 Poor Management and Monopoly Risk

Jorgensen et al. (1998) considers that, public organizations are connected in a diplomacy and negotiation network that includes the organization and all external influencing actors. These organizations negotiate through well-formed networks and uphold long-term relationships of support only for survival. High levels of centralization provide greater coordination but less flexibility and rapid decision-making in a crisis creates burdensome procedures (Ziauddin, 2011).

Vaughan (1999) defines organizational misconduct as the acts of omission or commission by individuals or groups of individuals who violate their own organizations’ internal laws, rules, or administrative regulations on behalf of organization goals. She asserts these are common phenomenon organizations. Ziauddin, (2011) considers organizational mistake and misconduct such as ‘White colour crime’, ‘corruption’, ‘abuse of power’, as the organizational deviance or mismanagement that ultimately harm public and public have to pay for these. Crozier (1964) argues that a bureaucratic system of organization cannot correct its errors because the feedback process does not function well. This situation often takes place in Bangladesh’s electricity industry (TIB, 2007). Theft, misconduct and misappropriation are there (TIB, 2007). These events are considered as the inefficiency of the organizations.

Energy supply is one of the key functions of central governments in developing countries (Rambo, 2013). In most African countries, the energy sector is monopolized by government agencies, shouldering key functions such as energy production, distribution, billing and revenue collection (UN-Energy/Africa, 2011; UNEP, 2012). Monopolies in the energy sector were associated with inefficiencies such as inadequate supplies, frequent power outages and high user-fees (European Union, 2009). State-owned monopolies in the energy sector have been associated with poor quality of services in South Africa, Mauritius, Argentina and Ivory Coast (Pegels, 2009; Karekezi and Kimani, 2009).

2.3.5 Cost of Producing Electricity

In sub-Saharan Africa, the average cost of electricity generation in general is exceptionally high, due to the small size of electricity markets and the resulting lack of economies of scale (UNEP,
The situation is further deteriorated by the dependence on often expensive oil/diesel imports. Inefficiencies such as low historic levels of maintenance investment as well as electricity losses in generation and distribution also factor in. The average electricity generation cost in sub-Saharan Africa amounts to USD 0.18 per kilowatt-hour. This is more than double when compared to the tariffs found in South Asia of USD 0.04 per kilowatt-hour and USD 0.07 in East Asia (AfDB, 2010).

Renewable energy projects will often require additional information, which may not be readily available at any given moment, including historic weather-related data such as wind, sun radiation and precipitation. While such data can be easily obtained in developed countries, there is a large gap in the availability of this data in developing countries, particularly in those of the sub-Saharan region (Gaul, Kölling and Schröder, 2011).

General unfamiliarity with renewable energy technologies or uncertainties over their performance particularly problematic in countries with an insufficient track record – will often translate into projects requiring additional time or attention to permitting and financing. For these reasons, the transaction costs of renewable energy projects, including resource assessment, siting, permitting, planning, developing project proposals, assembling financing packages, and negotiating power-purchase contracts with utilities, may be much larger on a per kilowatt capacity basis than for conventional power plants (UNEP, 2012).

2.3.6 Human and Technical Barriers

Markets function best when everyone has low-cost access to good information and the requisite skills. But in specific markets, skilled personnel who can install, operate, and maintain renewable energy technologies may not exist in large numbers (Beck and Martinot, 2004). Consumers, architects, lenders, or planners may lack information about renewable energy technology characteristics, economic and financial costs and benefits, operating experience, maintenance requirements, and installation services. The lack of skills and information may increase perceived uncertainties and block decisions (Klunne, 2007). Generally, most of the countries lack specialization to undertake feasibility studies, detailed studies that would include detailed design and costing of the schemes to make a meaningful impact on utilization of small
Trained manpower capable of developing and manufacturing renewable energy technologies is a prerequisite for its successful deployment. Most renewable energy technology development will not only require low-skilled manpower, but also highly skilled, technical manpower (Thomas and Munson, 2009). Most of the countries in Africa do not have any facility to manufacture even the most rudimentary turbines or parts that might be critical in maintenance of the renewable energy schemes. An example is the availability of capacity to manufacture high-density polyvinyl pipes that can serve as good penstocks for the micro hydro schemes (Deichmann and Meisner 2010).

Sambo, Garba, Zarma, and Gaji, (2008) in their study found that in many of the power generating plants in Africa, there are poor technical staff recruitment practices, few or no capacity building and training programs in place to ensure adequate and competent personnel in this sector.

### 2.3.7 Infrastructural Barriers

Developing new renewable resources requires large initial investments to build infrastructure (Amigun, Brent, and Musango, 2011). These investments increase the cost of providing renewable electricity, especially during early years. Examples include:

Transmission lines carry electricity from power plants to cities, industry, and other locations where it is needed. Most renewable sources of energy therefore, require construction of new, expensive, and controversial transmission lines—and this has proven very difficult (Komor, 2009).

A study conducted in Nigeria by Sambo, Garba, Zarma, and Gaji, (2008) found out that electricity power transmission systems are technically weak thus very sensitive to major disturbances. Further, some sections on the transmitting grid systems are outdated with inadequate redundancies as opposed to the required mesh arrangement based on the country’s needs. Rambo (2013), reveals that, a major challenges affecting the production of power in Africa is that most of the fundings are done by the host governments themselves whose resource allocation cannot adequately meet all the requirements. The findings further reveal that these
governments lack the required funds to regular expand, update, modernize and maintain the network.

In most regions in Africa, the power distribution network is poor, the voltage profile is poor and the billing is inaccurate (Gaul, Kölling and Schröder, 2011). A report by Kwoka, (2008) indicate that poor management of power lines has led to a regular vandalization of the lines, this according to Kwoka is associated with low level of surveillance and security on all electrical infrastructure. Cole (2004) in his report about restricting power production in Nigeria found out that most of the technologies used generally deliver very poor voltage stability and profiles. Further, there was a high prevalence of inadequate working tools and vehicles as well as in adequate spare-parts for urgent operational maintenance and maintenance of the network. Sambo, Garba, Zarma, and Gaji, (2008) in their study found out that there is a serious lack of required modern technologies for communication and monitoring; most of the transformers deployed are overloaded in most service areas with week Feeder Pillars. Further some of the equipment’s used in communication are poor and obsolete thus leads to delays addressing important customer issues.

2.3.8 Low Investment

A report by Coenraads, Voogt, and Morotz, (2006) notes that investors are generally hesitant to invest in renewable energy projects. This is especially the case in countries where there has been a lack of a long-term framework for renewable energy support. Reluctance of investors may result into lack of funding for renewable energy developments. On the other hand, uncertainty about the renewable energy market triggers investment banks to lower their risk by charging high risk premiums, by requiring long-term contracts with consumers as well as by requiring guarantees for minimum prices (Mukheibir, 2007).

Some markets, which do not provide direct capacity payments, have shown difficulties in attracting new private investment (Ronan, 2005). This has led to either tender competitions for power purchase agreements or calls to build more publicly owned generation. It has been pointed out that there is little incentive for generation investors to consider fuel price shocks as they are
often passed on fully to customers leaving generator profitability relatively unaffected (Mbuthi Yuko, Karekezi and Kithyoma 2005).

2.4 Alternatives to Hydroelectric Power Sources in Kenya

A lot of investment has been made towards the development of a number of energy options to able the country meet its growing demand for clean energy services (Yves, 2013). With 60% of its installed capacity based on renewable energy, Kenya is recognized for the contribution it makes to renewable energy development in Africa (Muzee, 201). The energy sector is characterized by various sources and options of energy which are strategic in strengthen the country’s energy security and free itself from costly fossil fuel imports (IEA Statistics 2008).

2.4.1 Solar Energy

Solar power is a renewable energy that taps the sun’s energy to produce electricity through a solar thermal system or by photovoltaic systems (Amigun, Brent, and Musango, 2011). Solar energy potential in Kenya is high. Kenya receives daily insolation of 4-6kWh/m2. Solar utilization is mainly for photovoltaic systems (PVS), drying and water heating. Being located along the equator most parts of the country receive sufficient sunshine required for solar energy harvesting. An estimated 220,000 solar PV units are currently in use in Kenya. The government is currently implementing a solar PV electrification of schools and other institutions in selected districts, which are remote from the national grid as part of a national strategy to enhance the contribution of renewable sources of energy to the overall energy supply mix (Byakola, Lema, Kristjansdottir, and Lineikro, 2009).

Approximately 5,000 square metres of collector area for solar water heating systems are installed annually in Kenya. This is based on the Ministry of Energy pre-feasibility studies done in the period 2006/7. Institutions such as schools, hospitals and prisons stand to benefit from installation of solar water heaters to reduce on cost of electricity. This is made more feasible with most areas in the country receiving more than six hours of sunshine daily. The Kenya government formulated the Solar Water Heating Regulation which it hopes will increase upscale of solar water heating technology (Muzee, 2011). The benefits the households and institutions are expected to get include: development and utilization of indigenous energy resources (the
sun); enhanced national energy security through diversification of energy supply mix and reduction in the over-reliance on petroleum imports; reduced demand for expensive fuel fired peaking power plants resulting from grid electricity peak demand attributed to water heating; increased environmental conservation through reduction of greenhouse gases; increased employment especially in the rural areas, capacity building and income generation resulting from the expanded solar water heating industry. Large scale uptake and development of the solar water heating is foreseen to lead to reduced unit costs as a result of increased economies of scale (MoE, 2011).

2.4.2 Wind Energy

Wind energy is one of the thriving renewables in the global arena and its use has been on the increase (Global Wind Energy Council, 2009). Wind energy has been used in Kenya primarily for water lifting since the beginning of the 19th century but its use declined with the advent of oil fired internal combustion engines, which are flexible and more convenient to use. However, with the rising cost of oil, the exploitation of wind energy is becoming increasingly more attractive, particularly in areas remote from the grid and oil supply outlets (Byakola, Lema, Kristjansdottir, and Lineikro, 2009).

The limited exploitation of wind energy prompted the government to develop a feed-in tariff policy, which provides for a fixed tariff not exceeding US$0.11 per kWh for installed capacity of up to 10 MW supplied to the grid from wind generated electricity. The high capital costs and lack of sufficient data on wind potential in Kenya are two key barriers that are undermining the exploitation of wind energy resources (Barbier, 2010). In addition, the volatility of wind energy and the potential to disrupt the base load and consistent power generation through its integration in the national grid have also contributed to its limited exploitation. Moreover, potential areas for wind energy generation are many miles from the grid and load centres, requiring high capital investment in transmission lines (Ellis, Lemma, Mutimba, and Wanyoike, 2013).

To promote investment in wind energy generation, the Ministry of Energy recently completed preparation of a broad National Wind Atlas. In addition, the government is promoting the development of wind-diesel hybrid systems for electricity generation under rural electrification.
program in areas remote from the national grid. In the meantime, a total of 550 Kilowatts are installed in Ngong and Marsabit, generating about 0.4 GWh of electrical power.

2.4.3 Geothermal Energy

Kenya and other East African countries suffer from frequent rationing of power caused by drought and siltation in the dams and also experience high variations of prices caused by the world fuel markets. Geothermal development thus offers an excellent opportunity for saving foreign currency, cushion the supply variations and meet ever increasing power demand. Geothermal energy also offers renewable, indigenous and environmentally friendly alternative to more traditional sources (Wetangula, 2012). However on this, a report by Apsara Authority (2005) quickly contradicts by stating that thermal generation is not preferred in Kenya due to the fluctuations in global fuel prices that make it an expensive option, which is why there is an emphasis on developing alternative sources of power generation.

Development of geothermal energy, which is indigenous, low cost, environmentally benign and reliable, seems to be the long-term solution to this problem. Several recent least cost power development plans (KPLC, 2005) has considered geothermal energy as a least cost source of electrical power in Kenya. Geothermal resources in Kenya are located within the Rift Valley with an estimated power potential of between 7,000 MW to 10,000 MW spread over 14 prospective sites. Geothermal is reliable way to produce energy, it’s not affected by climatic variability and it doesn’t need transported fuels. It is suitable source for base load electricity generation in the country (Aurela, 2011).

Kenya’s abundant geothermal energy is a viable alternative to hydropower as the main source of energy, though most of the resource base remains undeveloped as yet. The energy system expansion plan based on the Kenya’s strategy for the energy sector (2011 to 2030) set out in the ‘Least Cost Power Development Plan (LCPDP) ranks geothermal as the least cost generation source for base load to sustain Kenya’s increasing energy demand. In addition to its being a renewable energy source, the main advantages of geothermal energy are reliability, absence of fuel cost, and long plant life (GoK, 2008). However, the upfront costs are relatively high, which has deterred private investment. Thus for the purposes of expanding its geothermal resources, the
government of Kenya established the Geothermal Development Company (GDC), a state corporation mandated to fast track the development of geothermal resources in Kenya.

According to the National Energy Policy (2013), the country has 205 MW (megawatts) installed geothermal capacity and has put in place a geothermal development plan. GDC is in the process of acquiring 12 modern deep drilling rigs at a total cost of US$360 million to enable drilling of at least 60 wells per year with 140 MW geothermal generation capacity every year beginning from 2012/13 (GoK 2011). Electricity transmission for the proposed geothermal projects is planned in order to support the evacuation of the generated power. This transmission line project will specifically evacuate power from Menengai geothermal project to the national grid. This will improve power reliability, stability and reduce system losses on the national grid. It will also avail additional capacity that will facilitate extension of the grid to other areas. Geothermal development is an important step towards exploiting the estimated resource potential of over 7,000MW.

**Biomass Energy**

Biomass is a renewable energy resource derived from wastes of various human and natural activities (Amigun, Brent, and Musango, 2011). Biomass density in Kenya is moderate. There is potential to produce biomass for modern energy production. The government has identified substantial potential for power generation using forestry and agro-industry residues including bagasse (Aurela, 2011). The total potential for cogeneration using sugarcane bagasse is 193MW. Mumias Sugar Company, private entity, generates 35MW out of which 26MW is dispatched to the grid. However, opportunities by other sugar factories have not been exploited. The FiT policy provides for biomass generated electricity with a power fixed tariff not exceeding 8.0 US Cents per Kilowatt-hour of electrical energy supplied in bulk to the grid. Under this policy, an 18MW cogeneration project using cane bagasse at the coastal region of Kenya has been approved (GoK, 2011).

Over 80 per cent of Kenyans do not have access to modern energy services and rely on biomass for their daily energy cooking needs. As the population continues to grow and the economy
expands, competing demands on the existing resources will keep rising and demand on biomass in its many forms will continue to grow. The over-dependence can be explained by the undeveloped grid electricity infrastructure, high prevalence of poverty which limits the levels of economic power to afford grid power and other forms of modern energy, and poor supply chains for other fuels. Poorer households use greater quantities of traditional biomass (open fires), which are very inefficient and produce harmful emissions while higher income families tend to rely more on improved biomass cook stoves which are more efficient (Byakola, Lema, Kristjansdottir, and Lineikro, 2009).

2.4.4 Oil and Petroleum

Kenya has one of the largest crude oil refineries in East Africa, the 90,000-barrels-per-day (bbl/d) Mombasa refinery. The refinery typically operates below capacity and processes Murban heavy crude from Abu Dhabi and other heavy Middle-Eastern crude grades. In 2011, Kenya imported about 33,000 bbl/d of crude oil entirely from the United Arab Emirates, according to the Kenya National Bureau of Statistics (KNBS). Kenya imported 51,000 bbl/d of refined oil products in 2011, according to KNBS. (Climate Investment Fund, 2011). In 2011, Kenya consumed around 81,000 bbl/d of oil products. In mid–2012 oil was discovered in Kenya. This came after a long time of disappointing exploration activities in Kenya. The reserves became commercially viable after it was confirmed that there were around 300 million barrels worth of reserves. As of January 2014, Tullow said Kenya's Northern Basin could have an excess of 1 billion barrels of oil. Kenya's deposits may top 10 billion barrels (Laurea, 2011). The government of Kenya is focused at ensuring smooth and successful exploration of oil as this has a great potential impact on its economy in the years to come (Muzee, 2011).

2.4.5 Nuclear energy

In September 2010 Former Energy and Petroleum Ministry PS Patrick Nyoike announced that Kenya aims to build a 1,000 MW nuclear power plant between 2017 and 2022. For Kenya to achieve middle-income status, nuclear energy has been determined to be the best way to produce safe, clean, reliable and base load (constant supply) electricity. Nuclear and renewable sources of energy such as wind, solar and geothermal plants could play a major role in helping Kenya
achieve middle income status, as the reduction of carbon emissions becomes a higher priority (AIEA 2014). On the other hand, a study conducted by Deichmann and Meissner (2010) point to the fact that many countries in the world especially those in Africa do not have the capacity to venture into this kind of energy source. It’s too costly and risky.

2.5 Chapter Summary

The three research objectives have been dealt with in this chapter. The first objective was strategic decisions in solving energy crisis. This was followed by the challenges faced during generation of hydroelectric power. The last part, part 2.4 was about the alternatives to hydroelectric power sources in Kenya. The next chapters will be about research methodology, analysis, and conclusions and recommendations in chapter three, four and five respectively.
CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides the research design and methodology that was adopted in order to realize the objectives of the study and to help fill the knowledge gap. The study focused on the strategic management decisions adopted by the Ministry of Energy and the Energy Regulation Commission in the generation of electrical energy other than the traditional hydro-electricity. The first sub-section provides the research design followed by the target population as well as the sampling design that was adopted to identify the sample elements from the target population. Thereafter, data type and data collection methods, data analysis and the research procedures that will be used are explained in that order.

3.2 Research Design

A research design is the plan and structure of investigation so conceived as to obtain answers to research questions (Cooper and Schindler, 2000). It expresses both the structure of the research problem and the plan of investigation used to obtain empirical evidence on relations of the problem. According to Babbie and Mouton (2004), a research design is a plan or structured framework of how one intends to solve the research problem and to expand knowledge and understanding. Through a clear and well-developed research plan, the reader can develop a confidence in the methods used as the researcher maximizes validity and minimizes error.

The research design to be employed in this study will be descriptive in nature. Descriptive studies describe characteristics associated with the subject population (Cooper and Schindler 2000). It aims to answer who, what, where, when or how much about a situation under study. A descriptive design will help provide a clear description of the various strategic decisions adopted by the government and their effectiveness as well as their success in improving the energy sector in Kenya. Descriptive design will further help in understanding the extent to which inherent challenges affect the production of electricity and shade light on the other viable sources of generating electricity in Kenya other than hydro.
This design will be adopted due to its usefulness in studies to test the relationship between variables in a population. It is also appropriate in the collection of in depth information about the variables stated under study and thereby enabling the study to provide recommendations that are specific and relevant.

3.3 Population and Sampling Design

3.3.1 Population

According to Schindler (2008), population is the total collection of elements upon which inferences can be made. The larger set of observation is the population while the smaller set of this big population is called the sample. The target population of the study will be technical and professional experts who are both staff from MoE, ERC, KENGEN and independent power producers who have offices within Nairobi central district. The study will only target technical and field staff. These categories were settled on as they are the key drivers of electricity production in Kenya.

Table 3.1: Population Distribution

<table>
<thead>
<tr>
<th>Area</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ministry of Energy (MoE)</td>
<td>115</td>
</tr>
<tr>
<td>Energy Regulation Commission (ERC)</td>
<td>50</td>
</tr>
<tr>
<td>KENGEN</td>
<td>25</td>
</tr>
<tr>
<td>Independent Power Producers</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>200</strong></td>
</tr>
</tbody>
</table>

Source: (ERC 2013)

3.3.2 Sampling Design

Sampling is the selection of part of a whole to represent the entire population. The main objective of sampling is to estimate the population values from the information contained in the elements of the sample. According to Cooper and Schindler (2000) the basic idea of sampling is
that by selecting, some of the elements in a population the researcher may be able draw conclusion about the entire population.

3.3.2.1 Sampling Frame

According to Cooper and Schindler (2000) a sampling frame is a list of all people or households in a target population from which the sample will be drawn and to which sample data will be generalized. The sampling frame will be defined along the four areas identified. These set will be acquired directly from the respective area in their stations of operation within Nairobi Central District.

3.3.2.2 Sampling Technique

This refers to the mode of selecting the sample. The population size is based on the selected technical and field staff in the identified categories. Therefore the entire population could not be contacted hence a sample will be selected to represent the entire population. According to Saunders, Lewis and Thornhill (2003), the usage of a sample makes a feasible higher overall precision in a study.

This study will apply proportionate stratified sampling technique to choose the sample. According to Fox and Fayat (2007), a sample is any subset of the components of the population obtained for the purpose of getting studied and the selection process is known as sampling.

Stratified random sampling allows representation of various subgroups in the population (Mugenda and Mugenda, 2003). It also increases a sample statistical efficiency, provides data analysis for various subgroups, enables different research methods and procedures and is more efficient than random sampling (Cooper and Emory 1995). This type of sampling will guarantee adequate representation of the population from the seven strata representing the whole population. A proportionate sample percent of 30 will be adopted.

3.3.2.3 Sample Size

Sample size refers to the selected elements to be studied (Saunders et al., 2003). The sample size depends on variation in population and the variables under study. This sample is drawn from all
the selected categories of staff. Fox and Fayat (2007) have highlighted that the sample must be selected with care to be a good reflection of the studied population. Using a 30% proportionate sample, this study will make use of a total of sixty one (61) respondents as presented in the table below.

Table 3.2: Sample Size Distribution

<table>
<thead>
<tr>
<th>Area</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ministry of Energy (MoE)</td>
<td>35</td>
</tr>
<tr>
<td>Energy Regulation Commission (ERC)</td>
<td>15</td>
</tr>
<tr>
<td>KENGEN</td>
<td>8</td>
</tr>
<tr>
<td>Independent Power Producers</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>61</strong></td>
</tr>
</tbody>
</table>

3.4 Data Collection Methods

The researcher will make use of questionnaire in for data collection. The researcher will prefer it because it is cost effective, convenient to most people and it promotes objectivity. The questionnaire shall be designed in tandem with the research questions developed in the first chapter. The questionnaire will make use of both closed and open ended questions and will be divided into four major sections: - the first section will include respondent’s general information; the second, third, fourth and fifth sections will have questions covering content raised by the three objectives of the study in the order presented in the review.

Self-administered, delivery and collection approach will be used. The researcher will self-administered the questionnaires as this will result in moderately high response rates compared to other modes (Saunders et al. 2003) as they allow respondents to fill them at their convenience. They also assured respondents confidentiality and anonymity

3.5 Research Procedures

According to Cooper and Schindler (2000), research procedure involves a clear and concise description of all the steps undertaken in the study for the purpose of explicability. In designing
and testing the questionnaire, a copy will be given to the research supervisor for review and analysis. As this will be going on, the researcher shall make follow ups with the research office for an official introduction letter to take to management of the identified key areas, MoE, ERC, KENGEN, and selected independent power producers.

A pilot test will then be conducted on 12 staff, three from each of the categories to find out the reliability of the questionnaire before the actual administration. This will be validated after which the final questionnaires delivered to the respondents accompanied by a cover.

3.6 Data Analysis Method

The data analysis method adopted will be quantitative in nature and which involved the use of inferential statistics. In this, regression models as well as correlation analysis will be employed. The data obtained from the respondents through the questionnaire will then coded into numeric. Using SPSS findings will be analyzed in the form of correlation analysis, cross tabulations and regression analysis.

3.7 Chapter Summary

This chapter outlines the comprehensive methodology to be used for this study, the research design, sample identification, data collection, analysis and representation. It is a very important chapter for the researcher as it identifies the means to achieving the purpose of this intended study which is of extreme importance to the researcher. The chapter started with an introduction. The second section was the analysis of the research design. The population and sampling design were then analyzed and this included the sampling frame the sampling technique and the sample size. The data collection method followed by the research procedure was also analyzed and the chapter was closed with an elaboration of the data analysis methods. The next chapter will present research findings in relation to the research questions.
CHAPTER FOUR

4.0 RESULTS AND FINDINGS

4.1 Introduction

This chapter presents the analyzed results and findings of the study on the research questions concerning the data collected from the respondents. The first section covers background information, which presents response rate and demographic presentation of the respondents. The second section presents findings on the strategic decisions adopted by the Ministry of Energy in solving energy crisis in Kenya. This if followed by findings on the challenges that come with generation of electricity. The final section presents findings on effectiveness of the alternatives available in the generation of electric power other than by hydro means in Kenya.

4.2 Background Information

This section provides the background information concerning the response rate, gender, age of the respondents who participated in the study and their position distribution at their workplaces and finally the length of service the respondents have been working.

4.2.1 Response Rate

Response rate is the total number of respondents that participated in the study and it is presented as a percentage. This study had a sample size of 61 respondents both technical/field and professional experts who are staff from MoE, ERC, KENGEN and independent power producers with offices within Nairobi central district. The response rate was 79% and was presented in the table 4.1 below.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participated</td>
<td>48</td>
<td>79%</td>
</tr>
<tr>
<td>Non-participated</td>
<td>13</td>
<td>21%</td>
</tr>
<tr>
<td><strong>Total Sample</strong></td>
<td><strong>61</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>
From the table above, the total sample size was 61 respondents. It was reported that 48 individuals from the total sample size, participated and submitted their filled questionnaires while 13 others did not participate in the study.

4.2.2 Age

Out of 48 respondents, 2% of them were less than 25 years, 23% were aged between 26-30 years, and 27% had ages between 31-35 years while the majority accounting for 48% was over 36 years of age. These findings indicate that most of the population working in the energy sector is over 36 years of age.

<table>
<thead>
<tr>
<th>Age Bracket (Years)</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less the 25</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>26-30</td>
<td>11</td>
<td>23%</td>
</tr>
<tr>
<td>31-35</td>
<td>13</td>
<td>27%</td>
</tr>
<tr>
<td>Over 36</td>
<td>23</td>
<td>48%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>48</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

4.2.3 Gender

Table 4.3 presents summary findings of gender distribution of the participants in this study. These results clearly indicate that this is a field that is male dominated. Over 90% of the respondents are male with only 8% women.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>44</td>
<td>92%</td>
</tr>
<tr>
<td>Female</td>
<td>4</td>
<td>8%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>48</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

4.2.4 Position Level

In this study, the research focused on two main categories, management (professionals) and technical (field staff). Figure 4.1 is a summary of the respondent’s population in terms of their position in their organizations. Majority as presented in the figure were management (professionals), accounting for 58%. Field staff was fewer, accounting for 42%.
4.2.5 Length of Service

Table 4.4 presents a summary of the proportional time/length of service of the respondents in their occupation.

<table>
<thead>
<tr>
<th>Length of Service (Years)</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Years and Below</td>
<td>8</td>
<td>17</td>
</tr>
<tr>
<td>3-5</td>
<td>19</td>
<td>40</td>
</tr>
<tr>
<td>6-8</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>9 and above</td>
<td>16</td>
<td>33</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>100.0</td>
</tr>
</tbody>
</table>

From the table above, majority of the respondents, 40% had worked for between 3-5 years, followed closely by those who had worked for 9 years and more. Those with two years and less were 17% of the total population that participated in the study, with 10% with between 6-8 years of experience.

4.3 Strategic Decisions in Solving Energy Crisis in Kenya

4.3.1 Strategic Decisions in Solving Energy Crisis

The study sort to determine the strategic decisions in solving energy crisis. Coefficient of variation (CV) was the statistical tool that was used to determine the highly significant strategies that solve energy crisis. The coefficient of variation that is less than 0.4 symbolizes highly significant strategies.
Table 4.5 shows the highly significant strategies that solve energy crisis. The study reveals that a well-functioning and fully integrated internal market for energy is key to energy security (C.V of 0.31). Moderating energy demand can reduce the country’s external energy dependency (C.V of 0.34). Co-ordination of risk assessment and contingency plans can reduce electricity crises (C.V of 0.37). The study also found that preventing and mitigating oil supply disruptions can protect energy surges (C.V of 0.38).

Table 4.5: Strategic Decision in Solving Energy Crisis

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Dev</th>
<th>C.V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well-functioning and fully integrated internal market for energy is key to energy security</td>
<td>1.81</td>
<td>.571</td>
<td>0.31</td>
</tr>
<tr>
<td>Moderating energy demand can reduce the country’s external energy dependency</td>
<td>2.42</td>
<td>.821</td>
<td>0.34</td>
</tr>
<tr>
<td>Co-ordination of risk assessments and contingency plans can reduce electricity crises</td>
<td>1.65</td>
<td>.601</td>
<td>0.37</td>
</tr>
<tr>
<td>Preventing and mitigating oil supply disruptions can protect energy surges.</td>
<td>2.52</td>
<td>.967</td>
<td>0.38</td>
</tr>
</tbody>
</table>

Table 4.6 shows strategic decision options and ability to solve energy crises in Kenya. Kendall’s (π) and Spearman’s rho (ρ) was the statistical tool that revealed the level of significance.

From the table, the statement “Kenya should put in place efficient risk assessment plans and oil supply security measures” is significant at {0.692** (π) and 0.752**(ρ)}. “Strong policy measure to be enacted to protect critical energy infrastructure in Kenya” is significant at {0.750**( π) and 0.824**(ρ)}. “Government ought to trigger more private investments in the energy sector” is significant at {0.484**( π) and 0.467**(ρ)}. 
Table 4.6: Strategic Decision Options and Ability

<table>
<thead>
<tr>
<th>Option</th>
<th>Kendall's tau-b (τ)</th>
<th>Spearman's rho (ρ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenya should put in place efficient risk assessment plans and oil supply security measures</td>
<td>.692**</td>
<td>.752**</td>
</tr>
<tr>
<td>Strong policy measure to be enacted to protect critical energy infrastructure in Kenya</td>
<td>.750**</td>
<td>.824**</td>
</tr>
<tr>
<td>Government ought to trigger more private investments in the energy sector</td>
<td>.484**</td>
<td>.467**</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.7 shows the level at which respondents agree or disagree to the statement that effort should focus on developing more options of electricity supply. From the table, 60.4% of respondents strongly agree to the statement, 33.3% of respondents agree to the statement and 6.3% of respondents were neutral to the statement.

Table 4.7: Developing More Electricity Supply Options

<table>
<thead>
<tr>
<th>Effort should focus on developing more options of electricity supply</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree,</td>
<td>29</td>
<td>60.4</td>
</tr>
<tr>
<td>Agree</td>
<td>16</td>
<td>33.3</td>
</tr>
<tr>
<td>Neutral</td>
<td>3</td>
<td>6.3</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 4.8 demonstrates the level at which respondents agree or disagree that ministry should work together with other stakeholders to improve Kenya’s immediate preparedness in respect of possible disruptions. From the table, it is well shown that 68.8% of respondents strongly agree and 25% agree that ministry should work together with other stakeholders to improve Kenya’s immediate preparedness in respect of possible disruptions.

On the other hand, 6.3% of respondents are neutral to the statement.
Table 4.8: Ministry and Other Energy Stakeholders

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly Agree,</td>
<td>33</td>
</tr>
<tr>
<td>Agree</td>
<td>12</td>
</tr>
<tr>
<td>Neutral</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>48</strong></td>
</tr>
</tbody>
</table>

Table 4.9 demonstrates the level at which respondents in different positions agree and disagree to the statement that Kenya can work with other countries in the region in improving electricity supply. The results show that 57.1% and 42.9% of respondents from management category strongly agree and agree respectively. Contrary, 41.2% of respondents from operations category strongly agree, 41.2 % agree and 17.6% were neutral about the statement.

Table 4.9: Kenya and Other Countries

<table>
<thead>
<tr>
<th>Position/Operation</th>
<th>Kenya can work with other countries in the region in improving electricity supply</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly Agree</td>
<td>Agree</td>
</tr>
<tr>
<td>Management (Professional)</td>
<td>Count</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>57.1%</td>
</tr>
<tr>
<td>Operations (Technical/Field)</td>
<td>Count</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>41.2%</td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td><strong>51.1%</strong></td>
</tr>
</tbody>
</table>

4.3.2 Other Decisions to Solve Energy Crises in Kenya

The study also found that Kenya energy regulatory commission should have, operate and maintain 30 year energy master plan which is updated every 12 months. It also encourages the use of primary sources of energy like solar energy and wind power. The study also found that the cost of connecting and consuming electricity should be reduced and this will enhance citizen use.

4.4 Challenges in the Generation of HEP

The study aimed at determining the challenges faced in generating hydro-electric power. The study sorted information from evaporation, flooding, reduced water run-off and siltation of dams.
Table 4.10 illustrates the significance of the challenges of hydro-electric power generation. The study used coefficient of variation to rank the factors that cause highest challenges. From the table, evaporation is the highest challenge (with a coefficient of 0.29), flooding (0.34), reduced water run-off (0.39) and siltation of dams (0.46).

The study implies that evaporation and flooding have the highest impact in the production hydro power.

Table 4.10: Impact of Natural Calamities on HEP Generation

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Std. Dev</th>
<th>C.V</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaporation</td>
<td>2.17</td>
<td>.630</td>
<td>0.29</td>
<td>1</td>
</tr>
<tr>
<td>Flooding</td>
<td>2.21</td>
<td>.743</td>
<td>0.34</td>
<td>2</td>
</tr>
<tr>
<td>Reduced Water Run-Off</td>
<td>1.31</td>
<td>.512</td>
<td>0.39</td>
<td>3</td>
</tr>
<tr>
<td>Siltation of Dams</td>
<td>1.50</td>
<td>.684</td>
<td>0.46</td>
<td>4</td>
</tr>
</tbody>
</table>

4.4.1 Other challenges in the Production of HEP

Table 4.11 demonstrates the correlations of the factors that cause challenges of generating hydro-electric power. Political instability lead to destruction of renewable energy infrastructure ($r=-0.632^{**}$, $p<0.01$, N=48). Extreme insecurity leads to risks of breach of contract between governments and investors ($r=-0.464^{**}$, $p<0.01$, N=48). Policies governing investments in renewable energy are often altered by regimes in power for political gains ($r=-0.416^{**}$, $p<0.01$, N=48). Skilled personnel who can install, operate, and maintain renewable energy technologies are scarce ($r=-0.530^{**}$, $p<0.01$, N=48).

The table implies that there are significant correlations between factors that cause challenges in generating HEP.
**Table 4.11: Challenges in Production of HEP**

<table>
<thead>
<tr>
<th>Challenges of generating HEP</th>
<th>Pearson Correlation</th>
<th>Sig. (2-tailed)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Political instability can lead to destruction of renewable energy infrastructure.</td>
<td>-.632 **</td>
<td>.000</td>
<td>48</td>
</tr>
<tr>
<td>Extreme insecurity can lead to risks of breach of contract between governments and investors</td>
<td>-.464 **</td>
<td>.001</td>
<td>48</td>
</tr>
<tr>
<td>Policies governing investments in renewable energy are often altered by regimes in power for political gains</td>
<td>-.416 **</td>
<td>.003</td>
<td>48</td>
</tr>
<tr>
<td>Skilled personnel who can install, operate, and maintain renewable energy technologies are scarce</td>
<td>.530 **</td>
<td>.000</td>
<td>48</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.12 shows the cross-tabulation between policies governing investments in renewable energy and length of service in organization. From the table, 25% of respondents with work experience of 2 years and below agree that policies governing investments in renewable energy are often altered by regimes in power for political gains, 50% of the same respondents disagree or strongly disagree to the statement and 25% are neutral about the statement.

On the other hand, 31.6% of respondents with work experience between 3 and 5 years agree that policies governing investments in renewable energy are often altered by regimes in power for political gains, 26.3% disagree and 42.1% are neutral to the statement.

In total, majority of the respondents agreed on this statement at 43.8 %, while only 20.8 % disagreed. The rest were neutral.
Table 4.12: Policies Governing Investments in Renewable Energy

<table>
<thead>
<tr>
<th>Length of Service in Organization</th>
<th>Count</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 years and below</td>
<td>8</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>%</td>
<td>25.0%</td>
<td>25.0%</td>
<td>25.0%</td>
<td>25.0%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>3-5 years</td>
<td>19</td>
<td>6</td>
<td>8</td>
<td>3</td>
<td>2</td>
<td>19</td>
</tr>
<tr>
<td>%</td>
<td>31.6%</td>
<td>42.1%</td>
<td>15.8%</td>
<td>10.5%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>6-8 years</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>%</td>
<td>60.0%</td>
<td>40.0%</td>
<td>0.0%</td>
<td>0.0%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>9 years and over</td>
<td>16</td>
<td>10</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>16</td>
</tr>
<tr>
<td>%</td>
<td>62.5%</td>
<td>31.3%</td>
<td>6.3%</td>
<td>0.0%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>21</td>
<td>17</td>
<td>6</td>
<td>4</td>
<td>48</td>
</tr>
<tr>
<td>%</td>
<td>43.8%</td>
<td>35.4%</td>
<td>12.5%</td>
<td>8.3%</td>
<td>100.0%</td>
<td></td>
</tr>
</tbody>
</table>

Figure 4.2 illustrates the level at which respondents agree and disagree that lack of supportive policies for renewable energy projects, as well as limited enforcement of the same inhibits growth of this sector. As shown from the figure, 48% of respondents agree that lack of supportive policies for renewable energy projects, as well as limited enforcement of the same inhibits growth of this sector. Contrary, 25% of respondents disagree to the statement and 27% of respondents are neutral about the statement.

Figure 4.2: Supportive Policies for Renewable Energy

Figure 4.3 shows the level at which respondents agree and disagree to the statement that the cost of generating electricity is high due to dependence on expensive oil imports. From the figure, it
is well shown that 77% of the respondents agree to the statement, 8% disagree and 15% are neutral about the statement.

![Pie chart showing response percentages](image)

Cost of electricity generation is high, due to dependence on often expensive oil/diesel imports

**Figure 4.3: Cost of Electricity Generation**

### 4.4.2 Model Summary

Model summary is used when predicting the value of a variable based on the value of another variable. In this case, the variable being predicted is called the dependent variable or sometimes the outcome variable. The variable being used to predict the other variable's value is called the independent variable.

Table 4.13 provided the R and $R^2$ value. The R value is 0.632, which represented the simple correlation and, therefore, indicated a high degree of correlation. The $R^2$ value indicated how much of the dependent variable (*Barriers in the Generation of HEP*) can be explained by the independent variable, (*too many agencies, extreme insecurity, and political instability*). In this case, 39.9% could be explained, which is highly large.

**Table 4.13: Model Summary**

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.632a</td>
<td>.399</td>
<td>.358</td>
<td>.36072</td>
</tr>
</tbody>
</table>

a. **Predictors:** (Constant), Too many agencies, Extreme insecurity, Political instability

The ANOVA in Table 4.14 indicates that the regression model predicted the outcome variable significantly well. This is shown at the "Regression" row and at the **Sig.** column. This indicates
the statistical significance of the regression model that is applied. For this case, $P$ is 0.00 which is less than 0.01 and indicates that; overall, the model applied is significantly good enough in predicting the outcome variable.

Table 4.14: ANOVA

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>Df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Regression</td>
<td>3.808</td>
<td>3</td>
<td>1.269</td>
<td>9.755</td>
<td>.000b</td>
</tr>
<tr>
<td>Residual</td>
<td>5.725</td>
<td>44</td>
<td>.130</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>9.533</td>
<td>47</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. **Dependent Variable:** Barriers in the Generation of HEP

b. **Predictors:** (Constant)

Too many agencies involved in issuance of licenses pose a great barrier for investment in energy sector.

Extreme insecurity can lead to risks of breach of contract between governments and investors.

Political instability can lead to destruction of renewable energy infrastructure.

Table 4.15 below, **Coefficients**, provides the information on each predictor variable. This provided with the information necessary to predict how different factors hinders the generation of HEP.

It is well shown that both the constant and the predictor variables contribute significantly to the model (by looking at the Sig. column). By looking at the B column under the **Unstandardized Coefficients** column, the regression equation is presented as:

Table 4.15: Coefficients

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>T</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>1.297</td>
<td>.226</td>
<td>5.73</td>
</tr>
<tr>
<td></td>
<td>Political instability can lead to destruction of renewable energy infrastructure.</td>
<td>.164</td>
<td>.077</td>
<td>.299</td>
</tr>
<tr>
<td></td>
<td>Extreme insecurity can lead to risks of breach of contract between governments and investors</td>
<td>.110</td>
<td>.056</td>
<td>.272</td>
</tr>
<tr>
<td></td>
<td>Too many agencies involved in issuance of licenses pose a great barrier for investment in energy sector</td>
<td>.205</td>
<td>.058</td>
<td>.419</td>
</tr>
</tbody>
</table>

a. **Dependent Variable:** Barriers in the Generation of HEP
Barriers in the Generation of \( \text{HEP} = 1.297 + (0.164) \) (Political instability can lead to destruction of renewable energy infrastructure) + \((0.110)\) (Extreme insecurity can lead to risks of breach of contract between governments and investors) + \((0.205)\) (Too many agencies involved in issuance of licenses pose a great barrier for investment in energy sector).

**Other Challenges in the Generation of HEP**

Low demand for power in Kenya is due to lack of sufficient funds to finance its generation, as well as consumption. A good population of Kenyan live below poverty lines making it difficult for them to be able to afford the costs associated with HEP.

### 4.5 Alternatives to Hydroelectric Power Sources in Kenya

The study in this section aimed at assessing the alternatives to hydro-electric power sources in Kenya. The study sorted information from oil energy, wind energy, solar energy, biomass energy, nuclear energy and geothermal energy.

The study used coefficient of variation to rank the alternatives to HEP. From the study, oil energy \((0.113)\), wind energy \((0.118)\), solar energy \((0.156)\), biomass energy \((0.219)\), nuclear energy \((0.228)\) and geothermal energy \((0.240)\). The implication of the study is that oil energy, wind energy and solar energy are the easily adopted energy alternatives.

| Table 4.16: Ranking of Alternatives to Hydroelectric Power Sources in Kenya |
|-------------------------------|----------|----------|-----|-----|
| Oil Energy                    | 1.5417   | .17361   | 0.113| 1   |
| Wind Energy                   | 1.7083   | .20194   | 0.118| 2   |
| Solar Energy                  | 1.6389   | .25575   | 0.156| 3   |
| Biomass Energy                | 1.5833   | .34723   | 0.219| 4   |
| Nuclear Energy                | 2.0694   | .47120   | 0.228| 5   |
| Geothermal Energy             | 1.4028   | .33657   | 0.240| 6   |

#### 4.5.1 Correlations between Position and Oil as Preferred Alternative

Table 4.17 demonstrates the correlations between position and oil as preferred energy alternative. From the table, 18\% of management believe that oil energy is an alternative to small extend while 82\% of the same respondents believe that oil energy is an alternative to a large extend. On
the other hand, 5.9% of respondents from operations category believe that oil is an energy alternative to a small extend while 94.1% of the same respondents believe that oil is an energy alternative to a large extend.

**Table 4.17: Position and Oil as Preferred Alternative**

<table>
<thead>
<tr>
<th>Position/Operation</th>
<th>Count</th>
<th>Small Extend</th>
<th>Large Extend</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management (Professional)</td>
<td></td>
<td>5</td>
<td>23</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>18.0%</td>
<td>82.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Operations (Technical/Field)</td>
<td></td>
<td>1</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td>5.9%</td>
<td>94.1%</td>
<td>100.0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>6</td>
<td>39</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>%</td>
<td><strong>13.3%</strong></td>
<td><strong>86.7%</strong></td>
<td>100.0%</td>
</tr>
</tbody>
</table>

**4.5.2 Correlations between Alternatives in the Generation of HEP**

Table 4.18 shows the correlations between alternatives in the generation of HEP. From the table, alternatives to generation of electricity through hydro means correlates with wind at \( r=0.646^\**, \( p<0.01, N=48 \), geothermal at \( r=0.683^\**, \( p<0.01, N=48 \), biomass at \( r=0.421^\**, \( p<0.01, N=48 \) and nuclear at \( r=0.604^\**, \( p<0.01, N=48 \).

**Table 4.18: Alternatives in the Generation of HEP**

<table>
<thead>
<tr>
<th>Alternatives to Generation of Electricity through Hydro Means</th>
<th>Wind ( r )</th>
<th>Geothermal ( r )</th>
<th>Biomass ( r )</th>
<th>Nuclear ( r )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Correlation</td>
<td>( .646^**)</td>
<td>( .683^**)</td>
<td>( .421^**)</td>
<td>( .604^**)</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.000</td>
<td>.000</td>
<td>.003</td>
<td>.000</td>
</tr>
<tr>
<td>N</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
</tr>
</tbody>
</table>

\**. Correlation is significant at the 0.01 level (2-tailed).**

Table 4.19 shows to what extend the government of Kenya supports and promotes the development of wind power. From the table, 77.1% of respondents believe that the government of Kenya fully supports and promotes the development of wind energy technology while 22.9% believe that the government of Kenya supports and promotes development of wind energy to a small extent.
Table 4.19: Kenya Government Supports Development of Wind Energy

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Extend</td>
<td>37</td>
</tr>
<tr>
<td>Small Extend</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
</tr>
</tbody>
</table>

To determine whether solar technology have been well integrated in the production of electricity in Kenya, figure 4.4 was used. From the figure, 31% of respondents believe to a large extend that solar technology has been well integrated in the production of electricity in Kenya. On the other hand, 44% of respondents believe to a small extend that solar technology have been well integrated in the production of electricity in Kenya while 25% of respondents do not believe the statement at all.

Figure 4.4: Integration of Solar Energy

Table 4.20 illustrates the cross tabulation between experience and the government support for the exploration of oil reserves. From the study, 100% of respondents with 2 years and below believe to a large extend that government support the exploration of oil reserves as an investment for future prospects. On the other hand, 94.7% of respondents with 3-5 years believe to a large extend that government support the exploration of oil reserves as an investment for future prospects while 5.3% of the same respondents believe to a small extend.

The table also shows that 100% of respondents with 6-8 years believe to a large extend that government support the exploration of oil reserves as an investment for future prospects. On the other hand 81.3% of respondents with 9 years and above believe to a large extend that
government support the exploration of oil reserves as an investment for future prospects while 18.8% of the same respondents believe the latter statement to a small extend.

Table 4.20: Government Support of Oil Exploration

<table>
<thead>
<tr>
<th>Length worked in your organization</th>
<th>Count</th>
<th>Large Extend</th>
<th>Small Extend</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 years and below</td>
<td>8</td>
<td>0</td>
<td>8</td>
<td>100.0%</td>
</tr>
<tr>
<td>%</td>
<td>100.0%</td>
<td>0.0%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>3-5 years</td>
<td>18</td>
<td>1</td>
<td>19</td>
<td>100.0%</td>
</tr>
<tr>
<td>%</td>
<td>94.7%</td>
<td>5.3%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>6-8 years</td>
<td>5</td>
<td>0</td>
<td>5</td>
<td>100.0%</td>
</tr>
<tr>
<td>%</td>
<td>100.0%</td>
<td>0.0%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>9 years and over</td>
<td>13</td>
<td>3</td>
<td>16</td>
<td>100.0%</td>
</tr>
<tr>
<td>%</td>
<td>81.3%</td>
<td>18.8%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>4</td>
<td>48</td>
<td>100.0%</td>
</tr>
<tr>
<td>%</td>
<td>91.7%</td>
<td>8.3%</td>
<td>100.0%</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.21 shows the extent to which geothermal energy technology is well developed and utilized in Kenya. The table illustrates that 83% of respondents believe to a small extent that geothermal energy technology is well developed and utilized in Kenya while 2% believe to a large extent about the statement.

Contrary, 15% of respondents do not believe at all that geothermal energy technology is well developed and utilized in Kenya.

Table 4.21: Geothermal Energy Technology

<table>
<thead>
<tr>
<th>Geothermal energy technology is well developed and utilized in Kenya</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Extend</td>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>Small Extend</td>
<td>40</td>
<td>83%</td>
</tr>
<tr>
<td>Not at all</td>
<td>7</td>
<td>15%</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 4.22 illustrates the extent to which there is great potential in exploration of nuclear energy in Kenya. From the table, 52% of respondents believe to small extent that there is great potential in exploration of nuclear energy in Kenya while 25% of the respondents believe the statement to large extent.
Table 4.22: Exploration of Nuclear Energy

<table>
<thead>
<tr>
<th>There is great potential in exploration of nuclear energy in Kenya</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Extend</td>
<td>12</td>
<td>25%</td>
</tr>
<tr>
<td>Small Extend</td>
<td>25</td>
<td>52%</td>
</tr>
<tr>
<td>Not at all</td>
<td>11</td>
<td>23%</td>
</tr>
<tr>
<td>Total</td>
<td>48</td>
<td>100%</td>
</tr>
</tbody>
</table>

Figure 4.5 shows the extent at which Kenya is ready to take up the challenge of nuclear exploration. The figure shows that 54% believe that Kenya is not at all ready to take up the challenge of nuclear exploration. Thirty one per cent of respondents believe that Kenya is ready to small extent to take up the challenge of nuclear exploration while 15% of respondents believe to a large extent that Kenya is ready to take up the challenge of nuclear exploration.

Figure 4.5: Taking up of Challenges of Nuclear Exploration

Other Viable Alternatives

Respondents asserted that solid waste from cities can also be used as source of fermenting electricity producing gases. Coal power plants, liquefied natural gas power plant and or integrating several methods can be used as other ways of generating power.

4.6 Chapter Summary

This chapter has presented the findings and results in accordance to the data provided by the respondents who were working in Energy Sector in Kenya. The chapter provided analysis on the background information of the respondents. Under this we had the response rates, which showed that over 70% of the respondents participated in the study; the section also established that most
of the respondents had more than 36 years, most who were in the management (professional) category.

The first section, which covered objective one, provided analysis on the strategic decisions adopted by the Ministry of Energy in solving energy crisis in Kenya; this was followed by findings on the challenges that come with generation of hydroelectricity. The final section presented analysis on the findings on effectiveness of the alternatives available in the generation of electricity power other than by hydro means in Kenya.
CHAPTER FIVE

5.0 DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 Introduction

This chapter finalizes the knowledge gathered in the research paper. The first section covers the discussion of the research findings in light of the strategic decisions adopted by the Ministry of Energy in solving the energy crisis in Kenya. This is followed by discussion of the research findings in light of challenges that come with generation of electricity, and finally discussion of the research findings in light of the effectiveness of the alternatives available in the generation of electric power other than by hydro means in Kenya. The second section covers the conclusions of the research objective in light of research findings and the literature review, while the last section deals with the recommendation that have been proposed in light of the research that has been done.

5.2 Summary

The general objective of the study was to investigate the strategic management decisions taken by the Ministry of Energy and the Energy Regulation Commission on the generation of electrical energy other than the traditional hydro-electricity in Kenya. The study was driven to determine the extent to which strategic decisions adopted by the Ministry of Energy have solved the energy crisis in Kenya; the challenges that they face in the generation of electricity and the available alternatives in the generation of electricity other than by hydro means in Kenya.

The research design that was employed by the study was descriptive in nature. A descriptive design would help provide a clear description of the various strategic decisions adopted by the government and their effectiveness as well as their success in improving the energy sector in Kenya. The design was deemed relevant in the collection of in depth information about the variables under study thereby enabling the study to provide recommendations that were specific and relevant to all stake holders in this sector. A 30% proportionate stratified simple random sampling technique was the method used in the selection of elements in the population,
comprising of four categories; MoE, ERC, KENGEN, and selected independent power producers all within Nairobi Central District as the sampling frame. This technique was appropriate as it enabled the collection of data from the identified categories. A sample population of 61 respondents was adopted. Data collection was conducted by use of questionnaires that had both closed and open ended questions. The questionnaires were well structured and the respondents were guided by the interviewer through the illustrated answers to ensure that the respondents understood them and therefore they responded suitably. A pilot test was carried out to test the reliability of the data collection tool.

In the analysis of data, inferential statistics was used. The data was coded before being keyed in SPSS for analysis. Report of these analyses was presented in the form of correlation analysis, cross tabulation and regression analysis.

From the findings, it was revealed that a well-functioning and fully integrated internal market for energy is key to energy security. It was also found that moderating energy demand can reduce the country’s external energy dependency. The study also found that preventing and mitigating oil disruptions can protect energy surges. It was also found that the government ought to trigger more private investments in the energy sector. Co-ordination of risk assessment and contingency plans was also found to reduce electricity crisis.

The respondents also agreed that efforts should focus on developing more options of electricity supply, with over 90% of the respondent agreeing with the statement. Over 90% of the respondents agreed that the ministry should work together with other stakeholders to improve Kenya’s immediate preparedness in respect of possible disruption. From the results, it was found that all the respondents from the management category agreed to the statement that Kenya can work with other countries in the region in improving electricity supply, while over 80 % of the respondents from the operations category agreed to the statement.

From the findings on challenges of impact of natural calamities, it was shown that evaporation is the highest challenge, followed by flooding, reduced water run-off and finally siltation of dams. It was also found that political instability can lead to the destruction of renewable energy infrastructure; extreme insecurity leads to risk of breach of contract between government and
investors; and policies governing investment in renewable energy are often altered by regimes in power for political gain. Majority of the respondents agreed on the last statement at 43.8 % while only 20.8 % disagreed. The rest were neutral.

The findings also revealed that majority of the respondents agreed that lack of supportive policies for renewable energy projects, as well as limited enforcement of the same inhibits growth in this sector. Only 25% of respondents disagreed, while 27% were neutral. Majority of the respondents agreed to the statement that the cost of generating electricity is high due to dependence on expensive oil imports at 77%. 15% were neutral while 8% disagreed. It was also found that too many agencies involved in the issuing of licenses poses a great barrier for investment in the energy sector.

From the findings, it was observed that majority of the respondents, both in the management and the technical field, at 82% and 94% respectively, believe to a large extent that oil is an energy alternative to hydroelectric power. The findings also showed the preference of the alternatives to hydroelectric power as biomass being the least preferred alternative, followed by nuclear energy, wind energy, and finally geothermal energy as the most preferred alternative. It was also observed that more than three quarters of the respondents believe that the government of Kenya supports and promotes the development of wind energy to a large extent while the rest believe that it does so to a small extent.

As concerning solar technology, a third of the respondents believe to a large extent that solar technology has been well integrated in the production of electricity in Kenya. Almost half of them believe it has been well integrated to a small extent, while a quarter of them do not believe in the statement at all. From the study, nine out of ten respondents believe to a large extent that the government supports the exploration of oil reserves as an investment for future prospects, while the rest believed the same to be so to a small extent.

In regards to geothermal energy technology, 83% of the respondents believe to a small extent that geothermal energy is well developed and utilized in Kenya, while only 2% believe this is so to a large extent. 15% of the respondents do not believe this is so at all. From the respondents, it was observed that slightly more than half of them believed to a small extent that there was great
potential in exploration of nuclear energy in Kenya. A quarter of them believed so to a large extent, while the rest did not agree with the statement. On the contrary, slightly more than half of the respondents did not believe that Kenya is ready to take up the challenges of nuclear exploration, a third believed so to a small extent, while about 15% believed so to a large extent.

5.3 Discussion

5.3.1 Strategic decisions in solving the energy crisis in Kenya

From the findings, it was revealed that a well-functioning and fully integrated internal market for energy is key to energy security. It was also found that Kenya can work with other countries in the region in improving electricity supply. As it is in the European Union, a well-developed trading mechanism and liquid spot market can offer effective short term solutions in event of disruption, as is already the case for oil or coal. The same security can be achieved for gas and for electricity, provided that pipeline capacity and grids are available to transmit supplies from one place to the other (Alan, 2007).

It was also found that moderating energy demand can reduce the country’s external energy dependency and exposure to price hikes. This can be achieved through legislating relevant legislation that should be implemented rigorously and without delay. A good example is in the EU’s Energy Efficiency Directive (“EED”) and the Energy Performance of Buildings Directive (“EPBD”) (Charles, 2011)

The study revealed that the ministry should work together with other stakeholders to improve Kenya’s immediate preparedness in respect of possible disruptions. In view of current events in many countries and the potential for disruption to energy supplies, short term action must focus on those countries that are dependent on one single gas supplier (Ikeme and Ebohon, 2005). The study also revealed that the government ought to trigger more private investments in the energy sector. It should, for instance work together with regulators, transmission systems operators to improve the country’s immediate preparedness in respect to possible disruptions. Particular attention should be paid to vulnerable areas to enhance storage capacity, to develop reverse flows, to developing security of supply plans at regional level and to exploit more the potential of natural energy (Wu and Chen, 2004).
From the study, it was revealed that Kenya should put in place efficient risk assessment plans and oil supply security measures. For countries to ensure that they are solving energy crisis, they should enhance solidarity mechanisms. This includes coordination of risk assessment and contingency plans and protecting strategic infrastructure, (Barnes & Floor, 2009). A good example is the European Union which has an overriding priority. This is to ensure that the best possible preparation and planning improve resilience to sudden disruptions in energy supplies, that strategic infrastructure are protected and that the most vulnerable Member States are collectively supported (Charles, 2011).

It was also revealed from the study that preventing and mitigating oil supply disruptions can protect energy surges. The Kenyan government can borrow a leaf from the EU where, according to Wu and Chen (2004), found that the EU as a trading block has developed a regulatory framework for gas storage that recognizes their strategic importance for supply security. Furthermore, at international level, new security of supply instruments could be envisaged with key strategic partners. Pooling a minimal part of existing security stocks in virtual common capacity reserve could allow for rapid response in the case of a limited disruption (Hamilton, 2007).

From the study, it was also found that strong policy measures should be enacted to protect critical energy infrastructure in the country. According to Allan (2007), it is necessary to launch a wider debate on the protection of strategic energy infrastructure such as electricity transmission systems which provide crucial services for all consumers. This debate should address the control of strategic infrastructure by all entities, notably by state-companies, national banks or sovereign funds from key supplier countries.

Other decisions that were proposed by the respondents are that the Energy Regulatory Commission should have, operate and maintain a 30 year energy master plan which is updated every 12 months. The cost of connecting and consuming electricity should be reduced so as to enhance citizen use.
5.3.2 Challenges in the Generation of Hydroelectric power

From the findings on challenges of impact of natural calamities, it was found that evaporation is the highest challenge. The greatest loss of potential water resources from hydroelectric facilities comes from the evaporation of water from the surface of reservoirs. This loss of water would otherwise have been available for downstream use as well as for the generation of electricity (Winkler, Mukheibir and Mwakasonda, 2006). This is closely followed by flooding. Unexpected flooding can be detrimental to large dams where the large loads of sediments carried by the river settle in the dams and lakes. For in-stream hydro plants, large logs and vegetation can cause damage or block up the system (Mukheibir 2007).

It is then followed by reduced water run-off. A good example is when Kenya and Tanzania were forced in 2000 to ration electricity since the hydroelectric plants had been affected by persistent drought (Ongeri 2000). The least of natural calamities challenges is siltation. Siltation lessens the life span of dams and irrigation structures by reducing the depth of dams and hence the storage capacity. This can reduce the potential of dams to generate hydroelectricity (Winkler, Mukheibir, and Mwakasonda, 2006).

The study showed that political instability can lead to the destruction of renewable energy infrastructure. Political instability negatively influences the economic well-being of a nation (Dengerink, 2011). Environics, (2010) found that intra-state conflicts have been linked to the destruction of renewable energy infrastructure in Mali, Ivory Coast, Somalia and Egypt, among other countries. The study revealed that extreme insecurity can lead to risk of breach of contract between governments and investors. In extreme cases, renewable energy projects have been expropriated. For instance, in 2010, Malian rebel groups expropriated wind farm projects in the Northern part of the country to boost their revenues (Government of Mali; 2012; AfDB, 2010).

The study showed that policies governing investment in renewable energy are often altered by regimes in power for political gain. Low-carbon policy risk relates to the question of how credible and reliable public policies, regulation and incentives are over a period of time, and how effectively they are implemented by responsible government departments and agencies (Helm and Hepburn 2003). In many African countries, the possibility that policies and legal frameworks
governing investments in renewable energy projects being altered or reversed to achieve political interests is real (UN-Energy/Africa, 2011). In many sub-Saharan Africa (SSA) countries, the risk of low-carbon policy is largely attributed to political instability, lack of supportive policies for renewable energy projects, as well as limited enforcement of necessary regulations (UNEP, 2012).

The study found that too many agencies involved in the issuing of licenses poses a great barrier for investment in the energy sector. Electricity generation at medium- to large-scale requires a number of legal and regulatory prerequisites by different government departments/stakeholders and authorities. The consequence is that there are too many agencies that are involved and it takes a long time to approve and issue licenses such as the environmental impact assessment licenses and generation licenses (Amigun, Brent, and Musango, 2011). The regulatory requirements by the different government departments are also uncoordinated. This implies that the electricity generation developers may be required to submit similar information and documents to the different departments or agencies. All these institutional and regulatory barriers have been cited by the developers as one of the largest hurdles in deploying renewable energy (Fakir and Nicol, 2008).

From the study, it was also shown that inefficiencies such as frequent power outages and high user-fees were ideal characteristics of government monopolies in energy. Energy supply is one of the key functions of central governments in developing countries (Rambo, 2013). In most African countries, the energy sector is monopolized by government agencies, shouldering key functions such as energy production, distribution, billing and revenue collection (UN-Energy/Africa, 2011; UNEP, 2012). Monopolies in the energy sector were associated with inefficiencies such as inadequate supplies, frequent power outages and high user-fees (European Union, 2009). State-owned monopolies in the energy sector have been associated with poor quality of services in South Africa, Mauritius, Argentina and Ivory Coast (Pegels, 2009; Karekezi and Kimani, 2009).

The study results showed that the cost of electricity generation was high, due to dependence on often expensive oil/diesel imports. In sub-Saharan Africa, the average cost of electricity generation in general is exceptionally high, due to the small size of electricity markets and the
resulting lack of economies of scale (UNEP, 2012). The situation is further deteriorated by the
dependence on often expensive oil/diesel imports. Inefficiencies such as low historic levels of
maintenance investment as well as electricity losses in generation and distribution also factor in.

From the study, it was revealed that skilled personnel who could install, operate, and maintain
renewable resources were scarce. Trained manpower capable of developing and manufacturing
renewable energy technologies is a prerequisite for its successful deployment. Most renewable
energy technology development will not only require low-skilled manpower, but also highly
skilled, technical manpower (Thomas and Munson, 2009). Most of the countries in Africa do not
have any facility to manufacture even the most rudimentary turbines or parts that might be
critical in maintenance of the renewable energy schemes.

The study showed that some sections on the transmitting grid systems were outdated and
found out that electricity power transmission systems are technically weak thus very sensitive to
major disturbances. Further, some sections on the transmitting grid systems are outdated with
inadequate redundancies as opposed to the required mesh arrangement based on the country’s
needs. Rambo (2013), reveals that, a major challenges affecting the production of power in
Africa is that most of the fundings are done by the host governments themselves whose resource
allocation cannot adequately meet all the requirements.

The study also showed that there was low investments rate in renewable energy projects by both
investors are generally hesitant to invest in renewable energy projects. This is especially the case
in countries where there has been a lack of a long-term framework for renewable energy support.
Reluctance of investors may result into lack of funding for renewable energy developments. On
the other hand, uncertainty about the renewable energy market triggers investment banks to
lower their risk by charging high risk premiums, by requiring long-term contracts with
consumers as well as by requiring guarantees for minimum prices (Mukheibir, 2007).

Other challenges that were found is that the country’s capacity to consume electricity is low due
to the fact that majority of the population lives below the poverty line, making it difficult for
them to be able to afford the cost of electricity. The lack of sufficient funds to finance the generation of electricity was also cited as a major challenge.

5.3.3 Alternatives to Hydroelectric Power sources in Kenya.

The study revealed that solar energy had a massive power potential in Kenya; and that the Government of Kenya had structures in place to support increased uptake of solar technology. Being located along the equator most parts of the country receive sufficient sunshine required for solar energy harvesting. An estimated 220,000 solar PV units are currently in use in Kenya. The government is currently implementing a solar PV electrification of schools and other institutions in selected districts, which are remote from the national grid as part of a national strategy to enhance the contribution of renewable sources of energy to the overall energy supply mix (Byakola, Lema, Kristjansdottir, and Lineikro, 2009).

The study also showed that solar technology had been well integrated in the production of electricity in Kenya. Approximately 5,000 square metres of collector area for solar water heating systems are installed annually in Kenya. This is based on the Ministry of Energy pre-feasibility studies done in the period 2006/7. Institutions such as schools, hospitals and prisons stand to benefit from installation of solar water heaters to reduce on cost of electricity. This is made more feasible with most areas in the country receiving more than six hours of sunshine daily. The Kenya government formulated the Solar Water Heating Regulation which it hopes will increase upscale of solar water heating technology (Muzee, 2011).

The study showed that the Government of Kenya supported and promoted the development of wind energy to a large extent. With the rising cost of oil, the exploitation of wind energy is becoming increasingly more attractive, particularly in areas remote from the grid and oil supply outlets (Byakola, Lema, Kristjansdottir, and Lineikro, 2009).

The study showed that geothermal energy offered the least cost in the generation electricity. The energy system expansion plan based on the Kenya’s strategy for the energy sector (2011 to 2030) set out in the ‘Least Cost Power Development Plan (LCPDP) ranks geothermal as the least cost generation source for base load to sustain Kenya’s increasing energy demand.
The study revealed that the Government of Kenya supported the exploration of oil reserves as an investment for future prospects. As of January 2014, Tullow said Kenya’s Northern Basin could have an excess of 1 billion barrels of oil. Kenya’s deposits may top 10 billion barrels (Laurea, 2011). The government of Kenya is focused at ensuring smooth and successful exploration of oil as this has a great potential impact on its economy in the years to come (Muzee, 2011).

The study revealed that Kenya is not ready to take up the challenges of nuclear exploration. A study conducted by Deichmann and Meissner (2010) point to the fact that many countries in the world especially those in Africa do not have the capacity to venture into this kind of energy source. It’s too costly and risky.

5.4 Conclusion

5.4.1 Strategic decisions by the Ministry of Energy in solving the energy crisis in Kenya

A good policy on generation of sustainable electric power is essential for the growth of a country’s economy. This is why the Ministry of Energy in Kenya has to have strong strategic plans to solve the energy crisis in Kenya. Increasing the country’s energy capacity to overcome major disruptions will create reliability of energy supply, thus guaranteeing proper forecasting by consumers such as manufacturers. Moderating the country’s energy demands can reduce external energy dependency, especially on oil generated power that has traditionally been sourced from foreign countries. Co-ordination of risk assessment and contingency plans reduces electricity crisis thereby giving a conducive environment for heavy energy users to operate in. The same applies to the prevention and mitigation of oil supply disruptions which protect energy surges. Kenya should also put in place efficient risk assessment plans and oil supply security measures and at the same time have strong policy measures to protect critical infrastructure. This can be ensured by having enough storage facilities for reserve stock and having a strong security force for the protection of infrastructure, especially terrorism. The government should also attract more private investments in the energy sector as a way of offloading the heavy responsibility that comes with being a monopoly. Efforts should be made on developing more options of electricity supply to mitigate the huge shortage of energy that is as a result of dependency on traditional sources of electricity. The country can work with other countries in the region in improving
electricity supply as they are the cheapest alternative when it comes to international co-operation in terms of trade in power sources.

5.4.2 Challenges in the generation of hydroelectric power

As in all other sectors, the government is bound to meet challenges in the execution of its responsibilities of providing affordable electricity to its citizens. Evaporation is the highest natural factor as a challenge in the generation of hydroelectric power. This is inevitable as the country lies within the equator where there is a lot of sunshine. This is followed by flooding, reduced water run-off, and finally siltation. Political instability can lead to the destruction of energy infrastructure. In case of a coup attempt, or civilian war, the government can lose its grip on vital parastatals, such as KENGEN and KPLC which have been mandated to generate and distribute electricity respectively. Extreme insecurity can lead to breach of contract between the government and investors. This is because the economy is adversely affected by insecurity thus the investor may doubt about recouping his investments. Policies governing investment in the energy sector are often altered by regimes in power for political gain. This is especially so in a developing country like Kenya where corruption within the government is rampant. There is also a shortage of skilled personnel who can install, operate and maintain energy producing technologies. This can be attributed to the poor state of the curriculum that is taught in public schools. Lack of supportive policies for renewable energy projects, as well as limited enforcement of the same has been found to inhibit growth of this sector. The cost of generating electricity has also been found to be high due to dependence on expensive oil imports. This is the case because the country has no other back up source of energy except oil. Too many agencies involved in the issuance of licenses also poses a great barrier for investment in the energy sector because investors shy away from rigorous bureaucracies involved in registering there firms.

5.4.3 Alternatives to hydroelectric power sources in Kenya

It is imperative that the government finds other alternatives to produce power other than the traditional hydroelectricity which is rain-fed, and thereby subject to climatic conditions. Oil has been found to be a preferred alternative, with the government embarking on oil exploration within its borders. Wind has also been found to be viable with the northern region of the country
being found suitable for its generation. Geothermal energy has also been exploited within the rift-valley region with immense success. Solar energy, with its great potential because of the country’s location along the equator, has however been underutilized. This may be because of the high cost of installing the equipment vis-à-vis the total output of electricity. Biomass, on the other hand, requires advanced technology to convert urban waste to generate energy. This may be an impeding factor. Natural biomass has been found to be wasteful and detrimental to the environment, thereby making it unattractive as a government policy. Nuclear energy, though being an attractive alternative, is many years away from its implementation due to the country’s economic situation. This is because it is a highly expensive venture in terms of human and monetary capital.

5.5 Recommendation

5.5.1 Recommendations for improvement

5.5.1.1 Strategic decisions to solve energy crisis in Kenya

The government should seek partnership with other countries to improve on its energy source. This includes partnering with other regional states such as Ethiopia to supply cheaper electricity since the country is well endowed with the facilities to do so. It also includes partnering with developed countries to prepare the country for the adoption of advanced energy producing technologies such as nuclear energy. The government should also broaden its electricity transmitting grid system so as to have a well-functioning and fully integrated internal market.

5.5.1.2 Challenges in the Generation of hydroelectric power

The government should put its house in order so as to attract other players in the energy producing sector. Insecurity, corruption and bureaucracy have been found to turn away investors not only in the energy sector, but in other potential investment areas in the country. The education sector, especially the institutions of higher learning should be overhauled so as to produce graduates who can measure up to international standards, especially so in the disciplines that are involved in the production of electricity. The government should put more effort in
returning the forest cover to its original state so as to reduce run-off, evaporation and siltation. This will ensure that rain water is retained for a longer time, thus reducing power shortages.

5.5.1.3 Alternatives to hydroelectric power source in Kenya

The industry players should focus more on the options of producing alternative energy to hydroelectricity that are commercially viable in the country at the moment. Options that are available include geothermal energy, which has not been fully tapped. Even though expensive during installation, its reliability and long plant life offsets any costs incurred in setting it up. The wind energy sector is yet to be fully exploited; the northern parts of the country should be connected to the country’s transmission grid so as to enable the tapping of this form of energy source. Policies should be put in place to encourage the use of solar energy such as scrapping all levies and taxes on imported solar energy equipment. This will make energy to be available even in the remotest parts of the country.

5.5.2 Recommendations for further studies.

The study focused on the strategies for the generation of alternative electricity to hydroelectric power in Kenya, and thus was limited to the country alone. There is need for a similar study to be conducted on the East African block of countries on a higher level. This is especially so as these countries try to emulate the European Union. Energy sufficiency is one of the economic pillars required to make the region an industrial hub and to have a middle income status.
REFERENCES


CIAT . (2011). ‘Future Climate Scenarios for Kenya’s Tea Growing Areas’ International Center for Tropical Agriculture (CIAT)


Karekezi S. & Kimani J. (2009). Have power sector reforms increased access to electricity among the poor in East Africa? Nairobi: AFREPEN.

Karekezi S. & Kimani J. (2009). Have power sector reforms increased access to electricity among the poor in East Africa? Nairobi: AFREPEN.


Dear Respondent,

I am a graduate student at the United States International University. In partial fulfillment of the requirement for the degree of Masters of Business Administration (MBA) degree program, I developed an interest of exploring the “Strategies for the Generation of Alternate Electricity to Hydroelectric Power in Kenya”.

This study seeks views from stakeholders in the energy sector focused in the production of Electricity in Kenya. The result of this study will provide various stakeholders (Government and Private energy producing entities) with the necessary information in understanding and developing cost effective measures of reducing overdependence on hydro power as the number one sources of electricity in Kenya. This is an academic research and confidentiality is strictly emphasized, your name will not appear anywhere in the report.

Please respond as honestly and as objectively as possible. Should you have any questions or concerns with regards to the questionnaire, please do not hesitate to contact me at any time through my contact provided below.

Thank you for your cooperation and time.

Yours sincerely,

NAMES

PHONE NUMBER
Appendix Two: QUESTIONNAIRE

PART I: General Information

1. Gender

[ ] Male [ ] Female

2. Position/Operation

[ ] Management (Professional) [ ] Operations (Technical/Field)

3. Age

[ ] 25 years and below [ ] 26-30 years [ ] 31-35 years [ ] 36 years and over

4. How long have you worked for your organization?

- [ ] 2 years and below
- [ ] 3-5 years
- [ ] 6-8 years
- [ ] 9 years and over
**PART II: STRATEGIC DECISIONS IN SOLVING ENERGY CRISIS IN KENYA**

1. On a scale of five; (1) Strongly Agree, (2) Agree, (3) Neutral, (4) Disagree and (5) Strongly Disagree, tick (as appropriate) your personal opinion for each statement.

<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ministry should work together with other stakeholders to improve Kenya’s immediate preparedness in respect of possible disruptions</td>
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<td>2</td>
<td>Effort should focus on developing more options and of electricity supply</td>
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<tr>
<td>3</td>
<td>Co-ordination of risk assessments and contingency plans can reduce electricity crises</td>
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<tr>
<td>4</td>
<td>Kenya can work with other countries in the region in improving electricity supply</td>
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<td>5</td>
<td>Preventing and mitigating oil supply disruptions can protect energy surges.</td>
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<td>6</td>
<td>Kenya should put in place efficient risk assessment plans and oil supply security measures</td>
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<td>7</td>
<td>Strong policy measure to be enacted to protect critical energy infrastructure in Kenya</td>
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<td>8</td>
<td>Moderating energy demand can reduce the country’s external energy dependency</td>
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<td>9</td>
<td>Government ought to trigger more private investments in the energy sector</td>
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<tr>
<td>10</td>
<td>Well-functioning and fully integrated internal market for energy is key to energy security</td>
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</tbody>
</table>

Kindly state any other decision that can be used to solve the energy crises in Kenya
PART III: CHALLENGES IN THE GENERATION OF HYDROELECTRIC POWER

2. a) On a scale of three; (1) Large Extend, (2) Small Extend and (3) Not at all, state to what extend do the following Natural and external calamities impact hydroelectric energy generation in Kenya. (Tick as appropriate)

<table>
<thead>
<tr>
<th></th>
<th>Large Extend</th>
<th>Small Extend</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>I   Evaporation</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>II  Reduced Water Run-Off</td>
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<td></td>
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<tr>
<td>III Flooding</td>
<td></td>
<td></td>
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<td>IV  Siltation of Dams</td>
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</table>

b) On a scale of five, (1) Strongly Agree, (2) Agree, (3) Not Sure, (4) Disagree and (5) Strongly Disagree, rate the following factors in the table below by ticking

<table>
<thead>
<tr>
<th></th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neutral</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Political instability can lead to destruction of renewable energy infrastructure.</td>
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<td></td>
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<tr>
<td>2</td>
<td>Extreme insecurity can lead to risks of breach of contract between governments and investors</td>
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<tr>
<td>3</td>
<td>Policies governing investments in renewable energy are often altered by regimes in power for political gains</td>
<td></td>
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<tr>
<td>4</td>
<td>Lack of supportive policies for renewable energy projects, as well as limited enforcement of the same inhibits growth of this sector.</td>
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<tr>
<td>5</td>
<td>Too many agencies involved in issuance of licenses pose a great barrier for investment in energy sector</td>
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<tr>
<td>6</td>
<td>Inefficiencies such as frequent power outages and high user-fees are ideal characteristics of government monopolies in energy</td>
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<tr>
<td>7</td>
<td>Cost of electricity generation is high, due to dependence on often expensive oil/diesel imports</td>
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<tr>
<td>8</td>
<td>Skilled personnel who can install, operate, and maintain renewable energy technologies are scarce</td>
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<tr>
<td>9</td>
<td>Some sections on the transmitting grid systems are outdated and technically weak</td>
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<tr>
<td>10</td>
<td>There is low investments rate in renewable energy projects by both government and private entities</td>
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</tbody>
</table>
Kindly state any other challenge that is encountered in the generation of hydroelectric power in Kenya

PART IV: ALTERNATIVES TO HYDRO ELECTRIC POWER SOURCE IN KENYA

3. On a scale of three; (1) Large Extend, (2) Small Extend and (3) Not at all, state to what extend the below statement are in realization of alternate energy supply option to the traditional hydroelectric power source.

<table>
<thead>
<tr>
<th>SOLAR ENERGY</th>
<th>Large Extend</th>
<th>Small Extend</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Solar energy has a massive power potential in Kenya</td>
<td></td>
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<tr>
<td>2. The Government has structures in place to support increased uptake of solar technology</td>
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<tr>
<td>3. Solar technology have been well integrated in the production of electricity in Kenya</td>
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<table>
<thead>
<tr>
<th>WIND ENERGY</th>
<th>Large Extend</th>
<th>Small Extend</th>
<th>Not at all</th>
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</thead>
<tbody>
<tr>
<td>4. Wind energy capacity has been exhaustively utilized in Kenya</td>
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<tr>
<td>5. The Government of Kenya fully supports and promotes the development of wind energy technology</td>
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<td>6. Wind energy technology is viable in Kenya</td>
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<table>
<thead>
<tr>
<th>GEOTHERMAL ENERGY</th>
<th>Large Extend</th>
<th>Small Extend</th>
<th>Not at all</th>
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</thead>
<tbody>
<tr>
<td>7. Geothermal energy offers the least costs in the generation of electricity</td>
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<tr>
<td>8. Geothermal energy technology is well developed and utilized in Kenya</td>
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<td></td>
</tr>
<tr>
<td>9. Government support for geothermal technology is sufficient</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>BIOMASS ENERGY</th>
<th>Large Extend</th>
<th>Small Extend</th>
<th>Not at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. There are large potentials of producing energy (electricity) by use of biomass.</td>
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<tr>
<td>11. Government supports production of electricity by use of biomass</td>
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<tr>
<td>12. Opportunities to generate electricity by use of biomass are rarely exploited in Kenya</td>
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<tr>
<td>13</td>
<td>Kenya over relies on petroleum and oil in the generation of electricity</td>
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<tr>
<td>14</td>
<td>Government support the exploration of oil reserves as an investment for future prospects</td>
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**NUCLEAR ENERGY**

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<tbody>
<tr>
<td>15</td>
<td>There is great potential in exploration of nuclear energy in Kenya</td>
</tr>
<tr>
<td>16</td>
<td>Kenya is ready to take up the challenge of nuclear exploration</td>
</tr>
<tr>
<td>17</td>
<td>Nuclear can help Kenya achieve middle income status</td>
</tr>
</tbody>
</table>

Kindly list other viable alternatives for the production of electricity in Kenya other than by use of the traditional hydro technology means.

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**THANK YOU FOR TAKING YOUR TIME TO COMPLETE THE QUESTIONNAIRE**