

**OPERATIONS STRATEGIES OF MANAGING EFFECTS OF
DROUGHT ON HYDROPOWER GENERATION: A CASE
STUDY OF KENYA ELECTRICITY GENERATING
COMPANY LIMITED**

**BY
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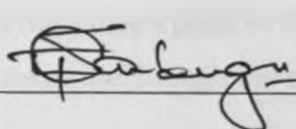
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DECLARATION

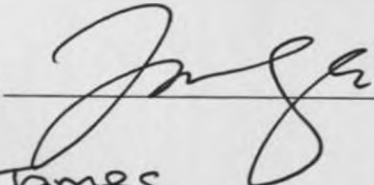
This management project is my original work and has not been presented for a degree course in any other University for academic purposes.

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This management project has been submitted for examination with my approval as the University Supervisor.

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DEDICATION

This project is a special dedication to my family; Florence and Gloria for their support, encouragement, endurance and above all love.

Special dedication goes to my parents Mr. Wambugu Mwihu and Mrs. Doris Wambugu. They have been my greatest pillar in life and I sincerely thank them for having brought me up so well and taken me through the education system which has made me whom I am today.

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LIST OF ABBREVIATIONS

ASP	Acres Simulation Programme
ATAs	Asset Transfer Agreements
CRM	Customer Relationship Management
DMP	Drought Management Programme
EDELCA	Electrificacion del Caroni
EDM	Electricidade de Mocambique
EGAT	Electricity Generation Authority of Thailand
EPP	Emergency Power Plant
ERC	Energy Regulatory Commission
ESKOM	Electricity Supply Commission
EWURA	Energy and Water Utilities Regulatory Authority
FIM	First Inter Monsoon
GDC	Geothermal Development Company
GOK	Government of Kenya
GSA	Geographical Society of America
GWh	Gigawatt Hours
G2G	Good to Great Strategy
HCB	Hidroelectrica de Cahora Bassa
ICMS	Integrated Climate Monitoring System
IPCC	Intergovernmental Panel on Climate Change
IPPs	Independent Power Producers
IWRM	Integrated Watershed Resource Management
KENGEN	Kenya Electricity Generating Company
KETRACO	Kenya Transmission Company
KPLC	Kenya Power and Lighting Company
KWh	Kilowatt Hours
KWh/m ² /day	Daily solar radiation
KVDA	Kerio Valley Development Authority

LCPDP	Least Cost Power Development Plan
LMB	Lower Mekong Basin
MTTPP	Medium Term Power Purchase Programme
MW	Megawatt
MWh	Megawatt Hours
MT	Metric Tonne
NAPA	National Adaptation Programmes of Actions (Malawi)
NERSA	National Energy Regulatory of South Africa
NEM	North East Monsoon
NDMC	National Drought Mitigation Centre
PIBO	Public Initial Bond offer
NCC	National Control Centre
NHI	National Heritage Institute
NMC	National Mekong Committee
NRC	National Research Council
PIS	Plant Information System
PPAs	Power Purchase Agreements
PDR	People's Democratic Republic
RDAs	Regional Development Authorities
RE	Renewable Energy
REFIT	Renewable Energy Feed-in Tariff
SCADA	Supervisory Control And Data Acquisition
SIM	Second Inter Monsoon
SPPA	Small Power Purchase Agreement
SPPT	Small Power Purchase Tariffs
SPSS	Statistical Package for Social Science
SWM	South West Monsoon
TARDA	Tana and Athi River Development Authority
TANESCO	Tanzania Electric Supply Company Limited

USD	United States Dollar
WCD	World Commission on Dams
WEM	Wholesale Energy Market
W/m ²	Wind power available per unit area swept by turbine blade

ABSTRACT

Ansoff (1987) had noted that the business environment was constantly changing and making it imperative for organizations to continuously adapt their activities in order to succeed. To survive in a rapidly changing dynamic environment, organizations needed strategies to focus on their customers and to deal with the emerging environmental challenges. The electric power sector in Kenya had undergone some structural changes since the adoption of Energy Sector Policy Framework Paper (1996-1998) with the unbundling of the hitherto vertically integrated Kenya Power & Lighting Company (KLPC) which was the sole; power generator, transmitter, distributor, and system operator; creation of KenGen and entry of Independent Power Producers (IPPs). Aosa (1998) had observed that organizations had to constantly adapt their activities and internal configurations to reflect the new external realities and failure to do so might put the future success of the organization in jeopardy

KenGen's 70% (749MW) of its power generation was hydropower based and it had faced numerous problems associated with hydrological drought when its capacity dwindled to about 20%. The effects had been tremendously felt by the economy and citizens with prolonged blackouts and expensive replacement emergency power. The main objectives of the study were to identify; what operations strategies KenGen had put in place to mitigate the effects of drought on hydropower generation and the underlying factors that impacted on management of hydropower generation in KenGen.

The study identified that KenGen had put in place strategies to address the effects of drought on hydropower generation among them; the growth strategy focusing on effective delivery of current projects, aggressive expansion of geothermal resource in the next ten years to raise installed capacity to 3,501.5MW by year 2018 and improving capital planning and execution; the regulatory strategy focusing on improving efficiency of the current single-buyer electricity market model through close collaboration with KPLC, KETRACO and ERC, maximizing value for KenGen with tariff restructuring; and the productivity strategy focusing on optimization of existing maintenance practices by

implementing planned and CBM programmes, reducing operational and overhead costs in fuel and maintenance work and improving operational effectiveness in procurement of spares.

The study also identified the underlying factors that impacted on management of hydropower generation as; non-implementation of raising of Masinga dam level to increase its capacity, lack of funds, inertia in planning for capacity expansion, environmental and social issues associated with displacement of people, lack of government funding and influence of MOE, KPLC and ERC in deciding the manner in which hydropower plants were dispatched, more so, during hydrological drought periods.

CHAPTER ONE: INTRODUCTION

1.0 Operations Strategies

Lawson (2001) had noted that operations strategy was the strategic management of core competencies, capabilities, processes, technologies, resources, and key tactical activities necessary in any supply network, in order to create the value demanded by a customer and Kim and Lee (1993) had described Operations Strategy as the effective utilization of the production capabilities to achieve business and corporate goals.

Skinner (1969) had described Manufacturing Strategy (Operations Strategy) as the exploitation of certain properties of the manufacturing (operations) function as a competitive weapon whereas Feurer et al (1995a,b) had indicated that research into strategic planning and dynamic strategy formulation and implementation had become a major focus of academia and industry to improve manufacturing and operations. Mintzberg et al (1998) and Pun (2003) had argued that this was so because with accelerating dynamics of the competition, the key to competitiveness no longer lied in employing strategies that had been successful in the past or emulating the strategies of successful competitors.

According to Foster (2001), operations strategy was “the total pattern of decisions which shaped the long term capabilities of an operation and their contribution to strategy”. He further argued that a firm’s operations strategy defined how it would compete in its own best way. The strategies consisted of policies and plan for how to use production resources to meet corporate strategic goals. Strategic decisions in the operations function involved competitive priorities. Operation strategy defined in which of the following priority (performance objectives) a firm should compete; cost, quality, speed and flexibility.

According to Skinner (1969,1974), he had observed that a company’s manufacturing (operations) function could do more than simply produce and ship products and had defined manufacturing (operations) objectives as cost, quality, delivery and flexibility and indicated that there was trade-off between them whereas Spring et al (1997) had labeled

these priorities respectively as; production and distribution of product at low cost; manufacturing of products with high quality or performance standards, meeting delivery schedules, reacting quickly to customer orders to deliver fast and reacting to changes in product, changes in product mix, modifications to design, fluctuations in materials and changes in sequence.

According to Hayes and Upton (1988), the present day customers were attracted by different attributes of products and services and in order to appeal to those who were interested primarily in the cost of a product or service, some companies attempted to offer the lowest price and others preferred to appeal to those customers who wanted higher quality (in terms of performance, features or appearance) and further still others sought to differentiate themselves through superior flexibility, dependability, speed of response or innovativeness.

Hayes and Upton (1988) had concluded that for a firm to have a positioning advantage over its competitors, it must begin with decision as to how it wanted to differentiate itself in its chosen market place. However, it could not give any long-term advantage over its competitors by focusing on a different customer's need if it continued to use the same manufacturing or service delivery process as its competitors did and that after deciding what kind of superiority it wanted to achieve, the company must configure and manage its operations organization in such a way that it could provide that form of advantage most effectively. The authors had further suggested that just as an engineered product reflected the combined influence of a variety of design parameters, an operations organization reflected the influence of its own set of design parameters. Some of these represented decisions regarding the organization's physical attributes, such as the amount of production (or service delivery) capacity that it provided.

1.1 Energy Sector in Kenya

According to the Ministry of Energy (MOE) Sessional Paper No.4 on Energy (2004), the commercial energy sector in Kenya was dominated by petroleum and electricity as the prime movers of the modern sector of the economy, while wood fuel provided energy needs of the traditional sector including rural communities and the urban poor and that at national level, wood fuel and other biomass accounted for about 68% of the total primary energy consumption, followed by petroleum at 22%, electricity at 9% and others at about less than 1%.

The International Energy Outlook (2008), had indicated that by and 2030, global energy consumption was projected to increase between 40 and 45 percent, with oil and gas, along with coal, continuing to meet the largest part of that demand whereas the MOE Sessional Paper No.4 (2004), on Energy expressed the aspiration to lay the policy framework upon which cost-effective, affordable and adequate quality energy services would be made available to the domestic economy on a substantial basis over the period 2004-2023. It recognized that the success of the socio-economic and environmental transformation strategies pursued by the Government then and in the future was to a large extent, dependent on the performance of the energy sector as an economic infrastructure.

1.1.1 Kenya electric energy portfolio

According to the KPLC Annual Reports (2008/2009), the country's electric power mix in megawatts was: Hydro 749MW (55%), Thermal 446MW (32.77%), Geothermal 163MW (11.98%), Wind 0.4MW, Cogeneration 2MW and others 0.25%, giving a total of 1,361MW as installed capacity and an effective capacity of 1,310MW.

According to the KPLC Annual Reports (2008/2009), out of the installed 1,361MW of electric power in Kenya, 1,019MW or 74.87% was owned by KenGen. The balance of 25.13% was generated by IPPs who mainly operated thermal power plants and Mumias Sugar Company that used cogeneration. The report further indicated that 749MW of the 1,019MW owned by KenGen or 73.50% was hydropower.

1.1.2 KenGen electric power production

KenGen was 70% GOK and 30% public owned company, through an Initial Public Offer (IPO) in year 2006. The company's task was to generate bulk electric power for the country using different modes of energy sources. The Company generated electric power from hydro, geothermal, thermal and wind sources.

KenGen sold all its bulk electric power to KPLC who were the sole transmitter and distributor of electricity in the country. The two companies had signed Power Purchase Agreements (PPAs) which governed such sales. The PPAs did not allow KenGen to directly sell electricity to consumers. KenGen was left with no option in case it preferred to directly sell power to large consumers at negotiated terms. This was one area that KenGen management was handicapped in as it could not get best value of its product by directly selling electricity to consumers and had to rely on a monopoly distributor of electricity, KPLC.

The PPAs were signed based on capacity and energy charges with the capacity charge being the larger component in the tariff. During drought periods, the dams were normally severely depleted of water and hence the hydro plants could not guarantee their rated power outputs and had to be downgraded in terms of capacity output by KPLC as per the PPA. This downgrading had financial implications on KenGen bearing in mind that the hydro plants were large capital investments. The Ministry of Energy Least Cost Power Development Plan (LCPDP) Study (2010), indicated that a hydropower dominated power system like Kenya's was vulnerable to large variations in rainfall and that climate change had proved to be a big challenge in the recent past with the failure of long rains that resulted in power and energy shortfalls.

The major hydropower dams on the Tana River Basin cascade, i.e. Masinga and Kiambere dams were owned by Tana and Athi River Development Authority (TARDA) while the Turkwel dam was owned by the Kerio Valley Development Authority (KVDA) with KenGen

owning the power plants. In the event KenGen needed to increase the dam capacities in order to hold more water during rainy seasons, they would have to be granted permission by the owning Regional Development Authority.

The excess water normally was spilt over to the river and this was energy lost which could have assisted in reducing the power outage period during drought seasons. This had impacted negatively on KenGen as they had to pay high fees for maintenance of reservoirs and losing on time when there was need to raise dam level to increase water holding capacity.

When hydrology was optimal, the hydropower could give an average of 15GWh per day and during drought period this could reduce to an average of 4.8GWh. This was about 68 percent reduction of hydropower generation which could lead to power rationing in the country which seriously affected all sectors of the economy and the social lives of the citizens as they had to endure many hours of electric power outages. The depressed hydropower generation also affected KenGen's revenue from energy sales thus affecting its ability to do more investment to enhance its electric power capacity and finance other company operations.

In trying to overcome the dangers of hydrological drought effects on its hydropower generation, KenGen had been forced to rethink its operations strategies in electric power generation for its survival. Viewed from above perspective, it could be argued that KenGen's operations strategy in electric power capacity expansion needed to be aligned with its strategic corporate goals.

1.2 Statement of the problem

Several studies on effects of drought and climatic variability on hydropower generation had been carried out in other parts of the world and few cases and key findings relevant to this study are given below:

According to NAPA (2006) in their study of the Zambezi River Basin, they established that there was influence of rainfall fluctuations on run-off, reservoir storage capacity and hydropower potential. It was concluded that to mitigate on the effects of drought on hydropower generation, strengthening of utilities to improve efficiency, sector planning to include a greater emphasis on climate vulnerability and development of renewable energy sources less sensitive to climate were necessary. Braga (2001) in his study on hydropower in Brazil, noted that the federal government was forced to announce power rationing plan to avoid blackouts from June till the onset of rainy season late October to early November, 2001.

Culbertson (2007) in a study on the climate change on water supply and availability in United States concluded that it was critical that application of best practice and technological advances to optimize water resources for the benefit of all users, planning and technology application was the best path forward. According to NMC (2005) in a study of drought management in the lower Mekong Basin, it was concluded that for better management policy, implementation of effective drought management programme could only be done if the institutional and management environment was sufficiently enabling both internally and externally. The study also concluded that to address drought forecasting problem, there must be improvement on availability and quality of drought related data.

A number of studies on problems affecting the electric power sector in Kenya had been conducted and the following are some of the key findings from the studies. Kiiru (2002) noted that to ensure the least cost per kilowatt, it was necessary for the electric power producers to sign long-term supply agreements with suppliers of spares and fuel whereas Njenga (2003) noted that the major obstacles on financing the electric power sub-sector were political risks and lack of well established legal and regulatory framework. Kagiri (2005) indicated that time and cost overruns in power projects in Kenya were caused by government bureaucracy and resource planning and Mwaka (2007) noted the factors affecting productivity in the large thermal power generation stations in Kenya as availability of spares and plant availability.

From the foregoing analysis, it seemed there was no study on strategies of managing effects of drought on hydropower generation in Kenya given the challenges it faced in meeting electric power capacity supply. This as earlier noted was due to overreliance on hydropower generation that was prone to drought conditions. Therefore, it was found useful to study the operations strategies that KenGen had implemented to mitigate drought effects on hydropower generation. The study therefore sought to answer the following questions:

- (i) What operations strategies had KenGen put in place to mitigate the effects of drought on hydropower generation?
- (ii) What were the underlying factors that impacted the management of hydropower generation in KenGen?

1.3 Objectives of the study

- (i) To identify the operations strategies KenGen management had implemented in addressing the problem of drought effects on hydropower generation;
- (ii) To identify the underlying factors that impacted on hydropower generation in KenGen;

1.4 Significance of the study

The study would be of benefit to the following:

- (i) The government policy makers on electric power capacity expansion could use the information to understand the effects of drought on hydropower capacity enhancement and aid in the formulation of better strategy in electric power sector.
- (ii) The KenGen Company in re-evaluating its operations strategies to mitigate against effects of drought on its hydropower generation capacity expansion and explore other sources of electric power generation.

- (iii) The KPLC Company in its policy on signing PPAs with bulk electric power producers.
- (iv) Academic and researchers to stimulate further research in the area of bulk electric power production in Kenya and take into cognizance the need for diversification of electric energy mix. The study will thus contribute to the existing body of knowledge.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

The literature review was to cover the types of electric power generation in Kenya, in particular the hydropower generation, hydrological drought and its effects on hydropower in Kenya and other parts of the world, social and environmental issues related to hydropower generation, impacts of climate on hydropower, reservoir simulation, modeling and drought forecasting, operationalization of PPAs and relationship management issues.

2.1 Types of electric power sources in Kenya

According to the MOE Sessional Paper No.4 on Energy (2004), there were about five primary sources for electricity in Kenya, i.e. hydropower, geothermal, co-generation, solar and wind.

The hydropower potential was concentrated in five geographical regions, representing Kenya's major drainage basins. The Lake Victoria basin has (43MW), Rift valley basin (264MW), Athi River basin (109MW), Tana basin (604MW) and Ewaso Ng'iro basin (146MW). Geothermal potential in Kenya was located within the Rift Valley. The Sessional Paper pointed out that studies and investigations indicated that Kenya's Rift Valley had a potential of more than 2,000MW that could be exploited for generation of electricity using conventional methods for at least 20 years. At present, 198MW of the estimated geothermal potential has been developed.

The MOE Sessional Paper No.4 on Energy (2004) had indicated that co-generation using bagasse as primary fuel was common practice in the domestic sugar industry in Kenya. Mumias sugar factory was the only company that was self-sufficient in electricity production and had the capacity to supply the excess to the national grid. Kenya had proven wind energy potential as high as 346 W/m² in some parts of Nairobi, North Eastern and Coast provinces. The installed capacity of wind turbines was 6.55 MW at Ngong and Marsabit. So far these systems had performed reliably well and electricity generation from wind was expected to play an important role in rural electrification, as it was relatively

much cheaper than oil-fired generation in remote areas inaccessible to the grid in the short to medium term. The report further pointed out that Kenya received good all year round solar insolation coupled with moderate to high temperatures estimated at 4-6 KWh/m²/day. This could be harnessed for water heating, cost effective crop drying and electricity generation for households and telecommunications facilities in isolated locations.

2.2 State of hydropower generation in Kenya

According to KPLC Annual Reports (2008/2009), hydropower generation in Kenya stood at 55 percent of the energy mix or 749MW. The 749MW capacity was fully owned by KenGen. The MOE Sessional Paper No.4 (2004), had indicated that undeveloped hydroelectric power potential, of economic significance was estimated to be 1,588MW, out of which 1,310MW was for projects of 30MW or higher.

The MOE Least Cost Power Development Plan Study (2010) indicated that there was a growing consciousness of the possibilities that small hydropower harnessing might offer vast generation options. The study further points out that only a few hydro schemes had been realized, either as part of the national grid supply or as stand-alone systems for agro-industrial establishments or missionary facilities. The MOE LCPDP Study (2010) had shown that the economic risk in hydropower projects could be large, because they were capital intensive. There was uncertainty with regard to power prices in the future, and the costs of building and producing hydropower varied strongly from power plant to power plant with some of the main variables being the size and location of the plant. The study also showed that a small hydropower plant required approximately as many people to operate as a large one although a large hydropower plant had a lower cost per kilowatt.

2.3 Hydrological drought and its effects on hydropower generation

There are several types of droughts but for the purpose of this study, hydrological drought was significant. According to Ojos Negros Research Group (2003), hydrological drought refers to a persistently low discharge and/or volume of water in streams and reservoirs, lasting months or years. The report further indicated that hydrological droughts were

natural phenomena, but might be exacerbated by human activities and are usually related to meteorological droughts, and their recurrence interval varied accordingly. Changes in land use and land degradation could affect the magnitude and frequency of hydrological droughts. There are other types of droughts, i.e. Meteorological, Agricultural and Socioeconomic droughts.

According to Munich Re (2004), the 2003 drought in Europe accounted for almost a third of the economic natural hazard losses and Cherry et al. (2005) found that most of the hydropower plants in areas affected by droughts suffered from reduced energy production due to lower water levels and this was especially crucial for an economy in a country like Norway that depended on hydropower. Cherry et al. (2005) study also concluded that droughts and long dry periods had led to serious power failures in Europe and in consequence to great economic losses in the industrial sector and tourism. The study had also indicated that European countries' agricultural GDP share was well below 5%, in most of the countries it was less than 3%. Therefore, in Europe drought impacts on the industry and service sector were more harmful to the economy than agricultural losses. The study had further pointed out that long-term drought effect on groundwater and surface water levels had a strong impact on power production and nuclear power plants as they might have to run on lower production rates because their cooling systems depend on rivers or lakes.

The Geological Society of America (GSA) (2006) had shown that virtually all sectors of society, the economy, and the environment are vulnerable to impacts from drought, and in many areas, that vulnerability was increasing with time. The report further pointed out that the power sector in the United States was vulnerable to drought as lower water flows reduced the amount of power generated and the revenues of the industry, increased costs associated with purchasing replacement power and increasing electricity rates for the customer. The report had indicated that fossil fuel and nuclear plants typically required large volumes of water to generate steam for the turbines and to use as cooling water. The

report concluded that when in-flow stream is lowered by drought, thermal discharge limits could potentially limit the operating capacity of some of these plants.

2.4 Managing drought effects on hydropower in other countries

Braga (2001) in his study on hydropower in Brazil had shown that hydropower had long been considered a sustainable and renewable energy source and that in Brazil, 90 percent of all electricity was produced in hydropower plants. The study had concluded that although standard planning and design of dams and reservoirs took into account of hydro climatic variability in the historical record, the underlying climate regime was assumed stationary whereas Shilomanov (1999) had indicated that that premise had been increasingly under scrutiny with regard to uncertainty in the long-term assessment of water resources.

According to Braga (2001) in his study, significant lowering of water levels in the reservoirs of many Brazilian hydroelectric power plants was attributed to the severe drought. The federal government was forced to announce power rationing plan to avoid blackouts from June till the onset of the rainy season (late October, early November). The report indicated that by September 2001 the reservoirs were working at minimum capacity (about 20 percent of the total volume), evidence of the failure of existing energy and water resources management plans to meet unexpected shortages. The study had also suggested that one interesting feature of the 2000-2001 drought was the mismatch between the modest magnitude of the meteorological drought (a small precipitation deficit as compared to the droughts) and the severity of the hydrological drought (large runoff deficit).

From a study by NAPA (2006) on the baseline period (1970-2000), it had been established that there was influence of rainfall fluctuations on run-off, reservoir storage capacity and hydropower potential in Zambezi River basin. The study had shown that climate change/variability; indeed had effects on hydropower generation and that significant wet and dry episodes were indentified in the sub basins for the baseline period of 30 years. The study ascertained the response of run-off, reservoir storage capacity and hydroelectric

power potential to extreme wet and dry years. The report had further indicated that hydroelectric power generation had been negatively affected by the droughts and floods. Drought had had devastating effect on the hydropower generation in Zambia with significant economic reduction in the power potential. According to NAPA (2006), In 1991/1992 rainy season, a devastating drought crippled many sectors of the economies in the riparian states of the Zambezi basin, amongst the worst affected were agriculture and hydroelectric power generation.

In order to mitigate the effects of drought on hydropower generation the study recommended strengthening electricity utilities to improve efficiency and financial viability. It also recommended strengthening of sector planning to include a greater emphasis on climate vulnerability and climate change risk by introducing, assessment of vulnerability of supply systems, including hydropower and the development of other renewable sources less sensitive to climate, assessment of climate change impacts on demand, increase off-grid expansion opportunities, support of the expansion and development of regional electricity access and energy efficiency, review of the effects of climate variability and climate change on the reliability and capacity of existing and potential hydropower facilities and developments, and accelerating the expanded pre-investment studies of hydropower and other renewable sources for grid and off-grid electricity supply.

According to National Heritage Institute (NHI) (2007) report on dam re-operation strategic plan in USA, they had indicated that from the arid West to the shrinking Great Lakes to the drought-struck Southeast, climate models consistently predicted longer, wetter winters followed by longer, drier, hotter summers. The upshot predicted a national crisis with erosion of water storage, power supply and river ecosystems. The report had shown that climate changes made water and hydropower dependent utilities face unprecedented extreme weather. The NHI (2007) had observed that severe weather triggered a chain reaction where water managers must operate dams conservatively in the face of radically altered rainfall and runoff patterns. The cautions to absorb potential floods made them

lower reservoirs and the lowered reservoirs then received less runoff during protracted droughts and consequently longer, hotter droughts more rapidly evaporated what runoff could then be captured. NHI had observed that the vicious cycle reduced the supply of the two precious resources of power and water that were most increasingly in demand.

NHI (2007) had argued that it had restored water resources by developing innovative solutions founded upon cutting-edge scientific, legal and policy analysis. They had further indicated that their hydraulic modelers, ecologists, fishery biologists, resource economists and planners worked in concert to improve decisions, optimize water, and preserve the aquatic ecosystems on which humans depend. NHI had also indicated that in California, they had pioneered techniques to link groundwater banks with dams to improve water supply, flood management, and river flows synergistically. The report further showed that NHI had integrating the largest Federal reservoir at Lake Shasta, the largest State reservoir at Lake Oroville, and the groundwater underlying both and that such conjunctive management secured supplies, eliminated risks, and restored habitats.

Barroso (2004) analyzed the hydrological risk faced by hydro plants in hydropower based markets in Brazil and possible mitigation measures and concluded that this risk that arose in low inflow seasons, could lead to high financial exposures of the agents in the spot market. Barroso (2004) had noted that in the case of Brazilian system, the assessment and mitigation of the hydrological risk was the insertion of a thermal power plant into the portfolio, which showed to be a good instrument, since it diversifies the portfolio's mix and provided benefits from the synergic gains between the energy sources.

Baykan et al (2006) in a paper on management of drought had noted that electricity production would be affected from drought especially in countries with a dominant hydropower presence. He had argued that to be able to mitigate the effects of drought and to take measurements, long and short term plans must be prepared by observing drought trend continuously. He had pointed out that drought management included not only organizing all water control facilities but also planning, designing, application, and

organizing. He had concluded that drought managers could reduce damage and cost of drought by applying effective drought management approaches, e.g. risk based planning. Baykan et al (2006) had cited the case of drought in Turkey in the 1990s and noted the harmful effects it had as decreased precipitation and decreased dam levels caused energy crisis.

Baykan et al (2006) had quoted the IPPC (1992) strategies against drought as; determining the flexibility and vulnerability of current hydrologic systems and water management systems; enhancing system-wide operation; enhancing scientific measurement, monitoring, knowledge and forecasting; and implementation of water conservation measures etc. The author had also suggested that; establishment of an Integrated Climate Monitoring System (ICMS), establishment of a regional/National Drought Mitigation Center; forecasting of drought and exchange of experiences as pre-requisites of application of the strategies against drought effects.

In a study on the occurrence of drought, seasonal rainfall trends and to understand the behavior of hydrological drought in the in wet zone hydropower catchment areas of Sri Lanka, Kumara et al (2004) had observed that electric Power was becoming one of the major crises in the country and establishment of mini hydropower schemes would give a reasonable solution for the problem since it tapped water at several points along the streams, especially during the South West Monsoon.

Werrick and Whipple (1994) of U.S. Army Corps Engineers Water Resources Support Center in a paper on National Study of Water Management during Drought concluded that the distinction between a drought problem and a water supply problem was essentially defined by the nature of the best solution. They had shown that urban areas that persistently used more water than the safe yield of their water supply systems might have frequent or even standing drought declarations that could only be eliminated through strategic water supply measures. Those measures could be structural, such as the construction of new reservoirs, or non-structural such as conservation.

According to National Mekong Committee (NMC) (2005) in a study of drought management in the Lower Mekong Basin (LMB) (Cambodia, Lao PDR, Thailand and Vietnam), they had shown that for better drought management policy, implementation of effective Drought Management Programme (DMP) could only be done if the institutional and management environment was sufficiently enabling both internally and externally. This component would therefore contribute to the evolvement of such an enabling management and policy environment as a framework for the improved cooperation within the programme and beyond, reaching out to other Mekong River Commission programmes, NMCs partner organizations and the public as whole.

They had argued that to ensure drought preparedness and mitigation measures, the gap between water supply and demand in the drought prone parts of the Lower Mekong Basin had to be determined through planning and promoting implementation of appropriate structural and non-structural measures to mitigate the negative impacts of drought.

NMC (2005) had concluded that there was much institutional expertise in place and considerable work in progress to improve drought management in the Lower Mekong Basin and that three key emerging aspects of the regional drought management and mitigation were; development of a regional drought forecasting and early warning method; drought impact assessment and monitoring; drought management policy formulation; and identification of regionally appropriate preparedness and mitigation measures.

According to Sharma and Vashishtha (2007), business was exposed to controllable and uncontrollable risks and that controllable risks were technologically manageable. They had argued that the real problem was one of tackling the uncontrollable risks, and till date, weather continued to be the most significant uncontrollable risk factor and more or less, all businesses were exposed to the weather risk in one-way or the other. They had also given examples of businesses that were exposed to weather risk as construction, energy (power), entertainment, manufacturing, retail, travel, tourism and many others but they had argued that the effect of weather on the agriculture and power sectors was substantial. They had

shown that the need for hedging these sectors against weather risk was obvious and did not require any defenses. In their conclusion they had suggested that the basic issue relates to evolving an appropriate, adequate and sustainable system of weather risk management and that weather derivatives were the recent tools that were being employed in varied degrees in different developed countries to manage the weather related risks.

2.4.1 Managing social and environmental issues related to hydropower generation

From a study by Tumbare (2008) on how the sustainability threats and challenges associated with managing Lake Kariba and the Kariba Dam wall had been managed by the Zambezi River Authority (ZRA), it was shown that the water resource served many users and had its sustainability threats of invasive weeds, water pollution, cyclic drought and flood events, the competing uses and multiple legislative provisions. The report had indicated that Lake Kariba was created in the late 1950s to provide water primarily for hydro-power production. The study had shown that Kariba dam wall, as an engineering structure, had its own sustainability challenges of effects of alkaline aggregate reaction, the spillway plunge pool stability and the general ageing of the dam structure.

Tumbare (2008) had also argued that the Tonga/Korekore people, who were displaced on both banks of the Zambezi River when Kariba Dam was built, still felt short-changed. The study had shown that stakeholders would be able to associate and relate to similar threats, challenges and experiences and use the management solutions being applied at Kariba. Tumbare had concluded that the threats and challenges so far experienced had been mitigated adequately with management programmes and tools having been put in place but suggested that a lot still needed to be done to improve the socio-economic living conditions of the displaced Tonga/Korekore people.

According to Myriam and Karin (2004) in a paper on World Energy Congress, Australia, they had shown the importance of managing the social and environmental aspects of hydropower. They had pointed out that there were significant variations among countries regarding the importance of hydropower and that in most developed countries;

hydropower was not a high-profile issue in the eyes of the public. They had argued that a large part of the world's hydropower plants were discreetly generating electricity and revenues while largely hidden from the public view, either because the sites were remote, or because the facilities were often underground and that other hydropower projects were in full public view and contributed much more than renewable energy through the storage capacity of reservoirs by providing essential services such as water supply, flood control, irrigation, improved condition of navigation and water-based transport, fisheries, and recreational opportunities, which were taken for granted by large segments of the population.

In their findings, Myriam and Karin (2004) concluded that in deciding on hydropower projects, governments had to consider a whole range of important policy objectives that were not internalized in market prices, such as maintaining secure primary energy supplies whilst preserving a certain independence from fuel imports; reducing undue fluctuations in electricity prices, and maintaining an uninterrupted electricity supply; protecting the lives and properties of citizens from floods and droughts; preserving the established rights of citizens with respect to expropriation; maintaining and enhancing living standards and economic equity among citizens; improving air quality, especially in urban centers; reducing greenhouse gas emissions to slow down climate change; and protecting the natural and cultural heritage.

2.5 Impacts of climate change on water supply and availability

According to Lettre (2000), businesses face up to 70 percent weather risk of some sort and that the US department of Commerce had estimated that nearly one-third of the US economy, involving transactions to the extent of \$3.8 trillion, was at risk due to the weather whereas Culbertson (2007) study on the impacts of climate change on water supply and availability in United States had indicated that the United States Congress needed to consider hydropower and its many system benefits as it debated and developed climate change policy for the U.S.

Culbertson (2007) had further argued that too often hydropower was overlooked or taken for granted and that was unfortunate because hydropower, a clean and domestic resource, had a significant role to play to combat climate change and that hydropower was the largest source of renewable power in the United States with a potential of 90,000MW. He had argued that the industry realized that the benefits hydropower brings to the table were threatened if climate change was left unchecked. Changes in local conditions, such as the timing and availability of water for power generation, would create challenges in meeting the country's increasing need for electricity, as well as have significant consequences to irrigation, recreation and water supply resources.

According to Culbertson (2007), in order to fully meet the challenges posed by the effects of climate change, the Congress should partner with the private sector to develop the needed strategies and responses and Federal investment in new advanced hydropower technologies, through economic incentives. He had also pointed out that research and development funding was critical to assist the industry in its planning and preparation for the impacts climate change would impose on the resource. Culbertson (2007) had suggested that it was critical that application of best practices and technological advances to optimize water resources for the benefit of all users and smart use of policy, planning and technology application was the best path forward.

Jenkins et al (2002) and Marengo et al (2002) in their studies on global warming had shown an increase in warmer surface temperatures globally and locally on most of South America in the 1980s and 1990s. They had indicated that the increase in observed temperatures was consistent with an increase in evaporative rate, a decrease in runoff production, and thus reduction of surface water inputs to hydroelectric reservoirs and the Geological Society of America (2006) had reported in a paper on managing drought and water scarcity in vulnerable environments that the economic, environmental, and societal impacts of drought can be severe and extremely costly.

The Geological Society of America (2006) had also indicated that vulnerability to drought, a routinely occurring part of the natural hydrologic cycle, was increasing in all parts of United States and that enhanced data and analyses could yield needed improvements in the fundamental understanding of the causes of droughts, prediction of droughts, and drought mitigation and management. The study had also shown that global climate change would result in temperature increases that directly and indirectly impacted the hydrologic cycle and would almost certainly lead to reduced water availability and increased vulnerability to drought in regions of the United States.

According Woodhouse et al. (2006), some scientists had found troubling indications that the slow northward movement of the storm-bearing winter jet stream, which would reduce rainfall and snowpack in the basin, may have already began and Seager (2007) had indicated that the computer model predictions were consistent with that observation. Woodhouse et al. (2006) in a paper on stream flow reconstruction for Upper Colorado River Basin had shown that the drought that started around the turn of the millennium should not be viewed as one of the occasional large droughts that had visited the region over the past 500 years but rather a harbinger of things to come, a chronic situation and the “new norm.”

2.6 Reservoir simulations, modeling and drought forecasting

Due to the recurrence of drought related problems on hydropower generation, this research study would be exploring on how reservoir simulation, modeling and drought forecasting could be used to manage available water and forestall long power outages during drought periods. It's in the light of this that the literature review in reservoir simulations, modeling and drought forecasting would be carried out.

In a study on the occurrence of drought, seasonal rainfall trends and to understand the behavior of hydrological drought in the in wet zone hydropower catchment areas of Sri Lanka, Kumara et al (2004) had shown that rainfall received at major hydropower stations in the wet zone was on the declining trend in the First Inter Monsoon (FIM), Second Inter

Monsoon (SIM) and North East Monsoon (NEM) periods. Rainfall received during South West Monsoon (SWM) showed an increasing trend during the time period for which the study was carried out. They concluded that the drought frequency was at a higher level during the FIM, SIM and NEM and they recommended that rainfall received in the wet zone hydropower catchments was on the declining trend during the FIM, SIM and NEM and therefore, in future water deficiencies in streams and reservoirs might occur frequently. Kumara et al (2004) had further argued that comprehensive studies were needed on this issue and advance time series models might lead to better results.

NMC (2005) study of drought management in the Lower Mekong Basin sought to address four key issues, drought forecasting, drought impact assessment, drought management policy and drought preparedness and mitigation measures. It recommended that to address drought forecasting, there must be improvement on the availability and quality of drought related data and forecasting information referring to the variable meteorological, hydrological, agricultural and social-economic drought conditions in parts of the Lower Mekong River Basin and that for drought impact assessment, there was need to improve generation, transfer and uptake of know-how of improved and tested drought management and mitigation strategies, which followed through technical and economic analyses of the underlying causes of drought impact and vulnerability and benchmarked against a suite of drought status, impact and response indicators.

According to Hamlet et al (2002) in a citation of American Society of Civil Engineers, they had stated that recent advances in long-lead climate forecasting had made it possible to produce useful stream-flow forecasts for the Columbia River Basin roughly six months earlier than existing forecasts that relied on snowpack measurements and the resulting increase in forecast lead time facilitates considerable improvements in system operating performance, especially in years of expected above average flows. They had also observed that in the current reservoir operating system, the so called "critical" and "assured refill" rule curves that restrict releases of hydropower generation in the period from August to December were based on critical (most severe low flow) and third lowest flow sequences

record, respectively. These rule curves provided appropriate protection of energy capacity and reservoir refill in extreme low flow conditions, but were restrictive in normal and high flow years until midwinter when operational stream-flow forecasts based on observed snowpack become available, and the climatological constraints were relaxed to account for expected summer stream-flows.

They had concluded that the use of long lead time stream-flow forecasts allowed operating constraints to be relaxed in years when there was a high likelihood of ample stream-flow. They had argued that more spot market energy sales could be made in the summer and fall/early winter because of increased available water for releases, and spill from reservoirs in wet years was also reduced.

2.7 The Future of Hydropower Generation

McCully (2000), had observed that for many years, large dams were promoted on the grounds that they provided “cheap” hydropower but today the argument that hydropower is cheap was no longer tenable. He had suggested that the costs and poor performances of large dams were in the past largely concealed by the public agencies which built and operated the projects but the true risks and costs of the dams were being forced into the open due to increasing public scrutiny and attempts to attract private investors to existing and new projects.

According to McCully (2000), private investors had looked at dams and found high construction costs, serious operational problems such as sedimentation and vulnerability to drought and floods, and long delays due to public opposition. Also, the World Commission on Dams (2000) had increased the dam builders’ costs through recommending stricter standards on public consultation and project planning and monitoring and McCully (2000), had also indicated that the combined impact of the inherent drawbacks of large dams and the competitiveness of other forms of electricity generation (especially natural gas), meant that only a tiny fraction of the privately funded power plants being developed around the world were dams’ based.

According to McCully and Wong (2004) in a paper on role of large hydropower projects and sustainable development, they had indicated that sustainable development required that policies and decisions were taken based on the comparison of the full range of relevant costs and benefits and on careful analysis that would strengthen environmental protection, protect cultures and consider the needs of future generations (WCD, 2000; World Bank, 1992; UK government, 1999) whereas the World Bank and WCD had indicated that projects had often not met their expected cost, performance or economic targets. They had also observed that while the operating costs of large hydropower dams were low compared to fossil fuel plants, their construction costs were extremely high, running into billions of dollars for major projects.

The World Bank (1996) study had established that inflation-adjusted cost overruns on 66 hydropower projects funded by the Bank since 1960s averaged 275% whereas compared to average cost overruns on World Bank thermal power projects of 6% and on a sample of over 2,000 development projects of all types of 11% as observed by Bacon et al (1996). The most recent of dams studied in detail by WCD, Thailand's Pak Mun large hydropower project commissioned in 1994, had a 68% cost overrun. In terms of economic returns, the WCD found that hydropower projects often failed to deliver their expected benefits.

2.8 Implementation of Power Purchase and Asset Transfer Agreements

KenGen had entered into Power Purchase Agreements (PPAs) with KPLC (2009) to govern the sale of bulk electric power. KenGen had several modes of electric power generation, i.e. hydro, geothermal, thermal and wind. Each mode of power generation was governed by its own PPA. KPLC was the sole electric power transmitter and distributor in the country thus giving it the benefits of a monopoly buyer, transmitter and distributor in the industry. The Energy Act (2006) mandated KPLC with the three functions and the firm also owned the entire national grid system. This monopoly advantage KPLC had gave it an upper edge in any power purchase negotiation with an electric power provider. The Energy Act (2006) had also empowered KPLC not to enter into any power purchase agreement with a potential power provider if the two parties did not agree.

The PPAs KenGen had signed with KPLC do not allow KenGen to sell its bulk power to any other preferred consumer and this had impacted negatively on KenGen revenues bearing in mind that KPLC factors in other charges on electricity bills that KenGen would not charge a customer and hence could negotiate better prices per unit sale. The Energy Regulatory Commission (ERC) approved the PPAs as it was the regulatory body and the watchdog that safeguards the interests of the public.

KenGen had also entered into Asset Transfer Agreements (2000) with Regional Development Authorities (RDAs) in usage of water held in the large hydropower dams that were owned by the RDAs. KenGen paid some fees for maintenance of the reservoirs and had to seek for authority from the RDAs if it intended to carry out any modifications on the dams, e.g. raising the dam level to increase water holding capacity.

2.8.1 Operationalization of PPAs and Energy Sector reforms in other countries

Implementation of PPAs in Tanzania

According to EWURA Annual Report (2008/2009), TANESCO was a power utility wholly owned by the government of Tanzania and owned and operated generation, transmission and distribution facilities in Tanzania Mainland. The report further indicated that Tanzania launched a programme for development of small power plants with exportable capacities from 100 kW to 10 MW by using renewable resources and to simplify implementation process they had adopted the standardized Small Power Purchase Agreement (SPPA) and the associated standardized Small Power Purchase Tariffs (SPPT). The standardization had simplified the expected development process, and negotiation time when a developer wanted to connect to the network. The report had indicated that the process would be further streamlined such that minimum time would be required for obtaining the necessary consents.

Implementation of PPAs in South East Asia

The International Review of Power Reforms Report (2001) noted that a model emerged in South East Asian countries which could be labeled as single buyer model with the

dominant generation and transmission utility as solely responsible for the supply to all distribution agencies and sources its supplies from its own generation plants, IPPs, and imports from neighboring regions. The report showed that the single buyer model had some drawbacks in that; the customer had no choice of supplier, but must purchase from the local supplier; the local distributor had no choice of supplier, but must purchase from the central utility in the industry, usually the dominant generation and transmission utility; the transmission remained in monopoly hands, and usually controlled by the dominant generator; and the central utility sourced its power from its own plants as well as IPPs which might be co-generation, conventional thermal and hydro plants as well as renewable sources.

According to the report, many PPAs were backed by government guarantees, since investors could not be sure that the purchaser of their power could charge adequate prices to end-users. The report indicated that many countries in the region were considering implementing further structural and regulatory reforms aimed to move beyond single buyer model to a deeper level of competition. The report singled out Thailand as an example of the most developed single buyer model and indicated that Thailand's electricity industry had been characterized by a high degree of vertical integration and monopoly. The report further indicated that the Thailand government intended to introduce the wholesale competition model which involved competition in the market that generally required some form of a spot market and direct competition among generators for sales. This arrangement would have a limited set of customers, generally the largest customers in the market, who would be able to choose their supplier.

Implementation of PPAs in Mozambique

The International Review of Power Reforms Report (2001) indicated that Mozambique power system was operated by two utilities, i.e. Electricidade de Mocambique (EDM), the national electricity utility and Hidroelectrica de Cahora Bassa (HCB), responsible for the operation of the Cahora Bassa power station and associated transmission infrastructure. The report further indicated that the government of Mozambique initiated a study on reform

and regulation of the electricity sector in 1997/1998 with an aim to introduce the benefits of increased efficiency through competition and new investment from private sector.

The study recommended the vertical separation of the industry and the introduction of a single buyer purchasing power under contract in order to introduce competition for the market in generation. Under this arrangement, distribution business would purchase power from the single buyer under the bulk supply tariff. This model could be extended through allowing direct contracting between generators and large customers, therefore removing the single buyer's monopoly and increasing competitive pressures at the generation level.

The report further indicated that competition could be increased by the introduction of wholesale competition, with generators selling power to large consumers and distribution business through a spot market or power pool and the model could be further extended to include retail competition with different suppliers competing to serve all classes of customer, if metering technology permitted. The study therefore recommended reform of the industry along the lines of single buyer model, with the establishment of a central power procurement business and with direct competition between generators and distribution businesses to supply large customers.

Implementation of PPAs in other parts of the world

According to a report by APS Review Downstream Trends (2009), on the power sector in Venezuela, it had been shown that state owned firms dominated the power sector with the largest Electrificación del Caroni (EDELCA) supplying 75 percent of Venezuela power needs which was a high degree of vertical integration as EDELCA also being the main power distributor.

In a report in the Energy Journal, by Ignacio and Linares (2008), on limitations of energy markets, they had shown that Europe as well as many parts of the world had experienced restructuring and liberalization process in the energy sector with an outcome of a market-

oriented model which to a large extent was opposed to the previous paradigm of vertical integrated companies and central energy planning.

Eberhard et al (2008) in a study on the state of power sector in the Sub-Saharan Africa had concluded that hybrid power markets would not disappear from the African landscape anytime soon and that to make the best of them, African governments and their development partners must strive to develop a robust institutional foundation for the single buyer model, with clear criteria for the power purchase (off-take) agreements and dispatches of power under those agreements. They further pointed out that African governments must nurture their planning capabilities, establish clear policies and criteria for allocating new plant opportunities, and commit to competitive and timely bidding processes and that institutions built on the new hybrid models also should reduce discretion in regulatory contracts and the outsourcing of regulatory functions to advisory regulators and expert panels.

Barroso (2004) in a study on Brazilian power system had observed that in order to hedge against the very high spot energy price volatility observed in Brazil, generators must sign bilateral contracts, which were key elements in the market design. He had noted that bilateral contracts, in Brazilian market design were purely financial hedges and that there were no physical bilateral contracts. He had argued that bilateral contracts provided an adequate hedge against spot price in the case of thermal plants in the event the spot price was low, the plant would not generate and meet its contractual obligations by purchasing cheaper energy at the Wholesale Energy Market (WEM) and conversely, if the spot prices were high, the plant would produce its own energy, thus avoiding expensive purchases.

According to Barroso (2004), for hydro plants in Brazil, bilateral contracts were not sufficient to provide an adequate hedge because the system was hydropower-dominated and spot prices were higher in drought situations, which were exactly when hydro plants had lower production capacity and needed to purchase energy to meet their contracts. He

had argued that if heavily contracted, a hydro plant could be exposed to extremely high prices in the dry periods, where it might not produce enough energy to meet its contract.

2.8.2 Organizations relationship management

One of the key objectives of this research case study was to identify the underlying factors that impact on hydropower generation. In this regard, it was found necessary to review some of the Customer Relationship Management (CRM) concepts that have been formulated by renowned scholars and later use them in making inferences and in analyzing the research study results and help in arriving at conclusions on the relationship management between KenGen and its customers, KPLC and RDAs.

According to Gifford (2002) in a paper on effective Customer Relationship Management (CRM), he had shown that CRM was an essential part of modern business management and that CRM concerns the relationship between the organization and its customers. He had also pointed out that customers were the lifeblood of any organization be it a global corporation with thousands of employees and a multibillion turnover, or a sole trader with a handful of regular customers and that the scope of CRM was the same in principle for the two examples and only the scope of CRM which vary drastically. Gifford further had indicated that in implementing CRM principles, successful organizations used three steps to build customer relationships, i.e. determine mutually satisfying goals between the organization and customers, establish and maintain customer rapport and produce positive feelings in the organization and customers.

The lesson that KenGen could learn from above concept was how to manage its relationship management with its customers, i.e. KPLC and RDAs as it needed them for its survival especially on the hydropower generation. Gifford (2002) had summed up that for the organizations and the customers both must have sets of conditions to consider when building the relationship, such as wants and needs of both parties, i.e. organizations needed to make a profit to survive and grow and customers wanted good service, a quality product and an acceptable price.

2.9 Summary and conclusions

Hydropower was relatively a cheaper renewable energy resource that could be beneficially exploited for the economic growth of a country that has river basins. It was very clear from the literature review that hydropower generation could be severely affected by hydrological drought and climatic variability to the detriment of economic growth of a country. Hydrological drought had been significantly singled out as the biggest threat to sustenance and enhancement of hydropower generation.

The literature review had also clearly shown that most countries had not developed good PPAs and regulatory frameworks to govern electric power generation sector. Single buyer model had come up as the most preferred choice of electric power market and that most power sectors especially in Africa had vertically integrated system where the national power utility owned generation facilities, transmission grid and distribution rights.

The literature review especially on implementation of PPAs in other parts of the world had been useful in evaluating the structure and effectiveness of the PPAs KenGen had signed with KPLC in bulk power sale. The concept of single buyer against wholesale market had been analyzed and compared and proposal made how KenGen can utilize the same concept of wholesale market to its benefit.

The case study had used operations management strategies and theories to evaluate the operations strategies KenGen had put in place in addressing the problem of managing drought effects on hydropower generation and in making inferences and conclusions in the case study findings.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Research Design

Orodho (2003) had defined research design as the scheme, outline or plan that is used to generate answers to research problems. To carry out the study of drought effects on hydropower generation in Kenya, and in particular the case of Kenya Electricity Generating Company (KenGen), the case study design was found the most appropriate as it cannot be generalized. Yin (2003) had defined a case study as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when boundaries between phenomenon and context are not clearly evident” and Merriam (1998) had indicated that by delimiting the object of study, the case, was “the single most defining characteristic of the case study research”.

The focus of the study was KenGen as an entity that commercially generated hydropower in Kenya. The community based and private mini-hydro plants were very few and not for commercial but self supply of electricity. Primary data was to be collected using two questionnaires as per the objectives of the study and secondary data would be mined from Business Plan, Power Purchase Agreements (PPAs), Project Reports, Archival Records maintained in the Company and interviews.

3.2 Data Collection

Mirriam (1998) had indicated that a case study research enabled the researcher to draw upon many approaches to data collection because “case study does not claim any particular methods for data collection” whereas Yin (2003) had shown that data for case studies might come from many sources, but he identified six important sources for data collection that were widely used: documentation, archival records, interviews, direct observation, participant observation, and physical artifacts.

This method was preferred as it would use multiple sources of evidence, create a case study database, and maintain a chain of evidence. Since commercial hydropower generation in Kenya was carried out by KenGen, the research endeavored to create a

database on information extracted from KenGen business plan, project reports, archival records and interview questionnaires. The first questionnaire had close ended questions and targeted a sample of twenty one respondents, i.e. Senior and Chief Engineers who worked in the power stations, Chief Officers who worked in Projects Department and Hydrologist and hence there was no need of sampling. The second questionnaire targeted a sample of eight respondents, i.e. Senior Managers of KenGen, who had been tasked with execution of the company's strategies and thus there was no need of sampling. The second questionnaire was formatted for interviewing respondents, who would also have the chance to write down answers to questions if they chose to. The secondary data was captured as per Appendix I.

3.3 Data Analysis

Marshall and Rossman (1999) had shown that data analysis was the process of bringing order, structure and interpretation to the mass of collected data and Yin (2003) had argued that maintaining a database that documents case study notes, reports, narratives resulting from the case research, and other pertinent information enabled the researcher to connect answers to the evidence collected in the case study. The writer had emphasized that the primary purpose of organizing data was to enable pre-processing of the data to correct problems that were identified in the raw data.

For this case study descriptive statistics, qualitative and content analysis methods were used to analyze data. Data collected through the first questionnaire was analyzed using descriptive statistics such as percentages, frequencies and Tables. Statistical Package for Social Sciences (SPSS) was used to aid in the analysis. Computation of frequencies in tables, charts and bar graphs, where applicable, was sought and used for data presentation.

Mugenda (2003) had argued that the primary purpose of the case study was to determine factors and relationships among the factors that have resulted in the behavior under study and that the investigation therefore made a detailed examination of single subject, group or phenomenon. In this research case study, it was pointed out that the secondary data would

be mined from Business Plan, Power Purchase Agreements (PPAs), Asset Transfer Agreements, Project Reports, Archival Records maintained in the Company and questionnaires.

According to Mugenda (2003), content analysis is the systematic qualitative description of the composition of the objects or materials of the study, i.e. it involves observation and detailed description of objects, items, or things that comprise the sample. The writer had argued that the purpose of content analysis was to study existing documents such as books, magazines, and photographs in order to determine factors that explain a specific phenomenon. In this case study, it was therefore necessary to use the content analysis approach in analyzing such data mined from Business Plan, PPAs and ATAs.

According to Mugenda (2003), qualitative analysis of data refers to non-empirical analysis and gives case study and content analysis as areas researchers may not require quantifiable data. The writer had further argued that a researcher might be interested in analyzing information in a systematic way in order to come to some useful conclusions and recommendations. Mugenda (2003) had concluded that in qualitative studies, researchers obtain detailed information about the phenomenon being studied, and then try to establish patterns, trends and relationships from the information gathered. Qualitative analysis was used to analyze the information collected through the second questionnaire and also supplemented in content analysis.

The objectives of the study as earlier stated were to identify the strategies on how KenGen management had been addressing the problem of drought effects on hydropower generation and the underlying factors that impacted on hydropower generation. In interpreting the findings of the case study the research endeavored to find if the objectives of the study were achieved and whether the work contributed to body of knowledge. Any conclusions drawn were those resulting from the study.

CHAPTER FOUR: DATA ANALYSIS, FINDINGS AND DISCUSSIONS

The study sought to identify the operations strategies KenGen management had implemented in addressing the problem of drought effects on hydropower generation and the underlying factors that impacted on hydropower generation in KenGen. Only KenGen generated bulk hydropower for commercial purposes in Kenya and that is why it was chosen for this case study.

4.1 Data Collection

Primary data was collected using two separate questionnaires which were administered according to the two objectives of the study, i.e. to identify; the operations strategies KenGen management had implemented in addressing the problem of drought effects on hydropower generation and the underlying factors that impacted on hydropower generation in KenGen. The questionnaire on indentifying the factors that impacted on hydropower generation in KenGen targeted KenGen employees at the level of Senior Engineer, Chief Engineer and Chief Officer and Hydrologist. These were employees who were tasked with managing power plants that generate bulk electricity, project implementation and hydrology issues.

The second questionnaire on identifying the operations strategies KenGen management had implemented in addressing the problem of drought effects on hydropower generation was administered to Managers who are departmental heads and tasked with execution of company's strategies. For response, the Managers were either interviewed or asked to fill in the questionnaire by themselves. A total of 21 Senior Engineers, Chief Engineers (Officers) and 6 Senior Managers and one Assistant Manager were interviewed in this study and one Manager was non-responsive. Secondary data was mined from Business Plan, Power Purchase Agreements (PPAs), and Asset Transfer Agreements as per Appendix I.

4.2 Data Analysis, findings and discussions

For ease of analysis, this chapter was divided into three sections as per the objectives of the study and method used to collect data.

4.3 Underlying factors that impacted on hydropower generation in KenGen

This section analyzed the data and findings from answers on questionnaire on underlying factors that impacted on hydropower generation in KenGen.

The completed responses of first questionnaire were serialized, double checked and coded to ensure quality control. Data from the coded questionnaires was entered into the computer using a data entry screen in EPIDATA software. Information entered into the computer was then verified to ensure accuracy. Statistical Package for Social Science (SPSS) version 17 was then used to clean and analyze the data. Results of the analysis were presented in form of tables and charts.

Table 1 below shows the characteristics of the respondents of first questionnaire. The information helped the researcher to judge whether the respondents were the right persons to give the information that was needed for the study.

4.3.1 Characteristics of the respondents

Table 1 below shows the length of time that the respondents had worked in KenGen. According to the table, 81.0% had worked for the company for 10 and above years while 14.3% had worked for between 1 and 3 years while 4.8% had worked for between 5 to 10 years. Length of time was crucial for the first questionnaire responses since it was an indicator of experience of the employees in matters related to hydropower generation.

Table 1: Characteristics of the Respondents

		Frequency	Percent (%)
Position Held at the Company	Chief Business Strategy Officer	1	4.8
	Chief Engineer	14	66.7
	Chief Officer	1	4.8
	Hydrologist	1	4.8
	Senior Engineer	4	19.0
	Total	21	100.0
Years Worked	'1-3yrs'	3	14.3
	'5-10yrs'	1	4.8
	'10yrs +'	17	81.0
	Total	21	100.0

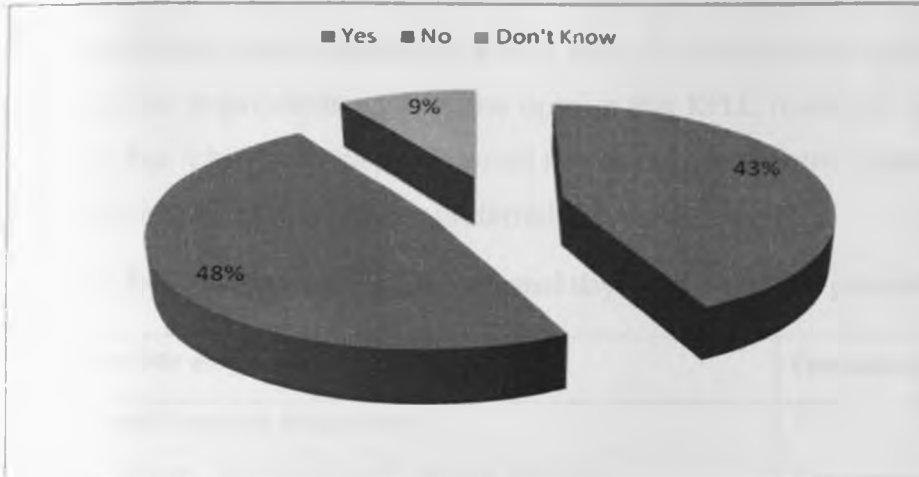
4.3.2 KenGen's electric power generation mix

The researcher had sought to know if KenGen, by having 70% of its power generation mix as hydro based was a good strategy and a 100% of all the respondents were unanimous that this was not a good strategy and that KenGen needed to invest more in other energy sources.

4.3.3 Hydropower PPA

Figure 1 below shows the responses when the respondents were asked if the current hydropower Purchase Agreement between KenGen and KPLC guarantees hydropower generation as the main source of electricity (base load). A total of 43% of the respondents said that the current hydropower purchase agreement guarantees hydropower generation as a base load while 48% were of the different view. Nine-percent of the respondents were not sure if the current hydropower Purchase Agreement guaranteed hydropower generation as a base load.

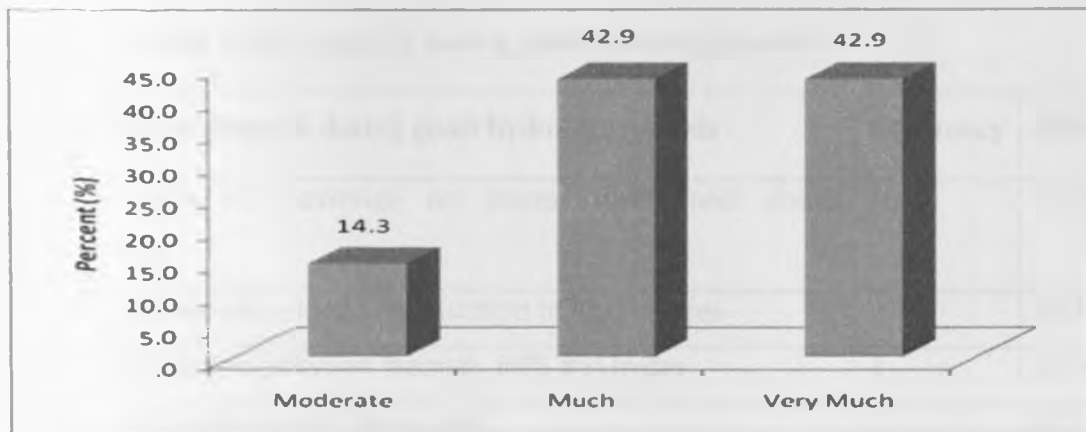
Figure 1: Is hydropower generation as a base load (main source) in the current PPA?



Impact of drought on hydropower energy sale revenue

Figure 2 below shows the impact of drought on hydropower energy sale. Respondents were asked to indicate the extent to which cyclic hydrological droughts affected KenGen's energy sale revenue from hydropower generation. Almost all the respondents were of the opinion that the drought had affected KenGen's sale revenue from hydropower generation.

Figure 2: Impact of drought on KenGen's energy sale revenue



KPLC dispatch on hydropower plants on normal days (Instruction to generate)

Table 2 below shows different modes on how KPLC dispatched KenGen's hydro plants in terms of electric power demand on a daily basis. According to the results in the table, more than half the respondents were of the opinion that KPLC made full dispatch only at peak times or that it balanced dispatch for all modes of power. Some respondents also said that KPLC did full dispatch all day or preferred to fully dispatch IPPS.

Table 2: Hydropower Dispatch on normal days (Instruction to generate)

Hydropower dispatch	Frequency	Percent (%)
Full dispatch only at peak times	11	52.4
KPLC balances dispatch for all modes of power	11	52.4
Full dispatch all day	5	23.8
KPLC prefers to fully dispatch IPPS	5	23.8
KPLC dispatches plants randomly	3	14.3

KPLC hydro plants dispatch during good hydrology periods

Table 3 below shows how KPLC dispatched hydro plants during periods of good hydrology to avoid spillage of water in the hydropower dams and 71.4% of the respondents said that KPLC did full dispatch to maximize on excess water and cheap hydropower.

Table 3: Hydro Plants dispatch during good hydrology periods

Hydro Plants dispatch during good hydrology periods	Frequency	Percent (%)
Full dispatch to maximize on excess water and cheap hydropower	15	71.4
Dispatch depends on load configuration in load centres	8	38.1
Dispatch balanced between thermal, IPPS and hydro	3	14.3
Full dispatch during peak times only	2	9.5
Dispatch is random	1	4.8

4.3.4 Impact of Meteorological Department rainfall forecast in planning hydropower generation

Table 4: Impact of Rainfall forecasts

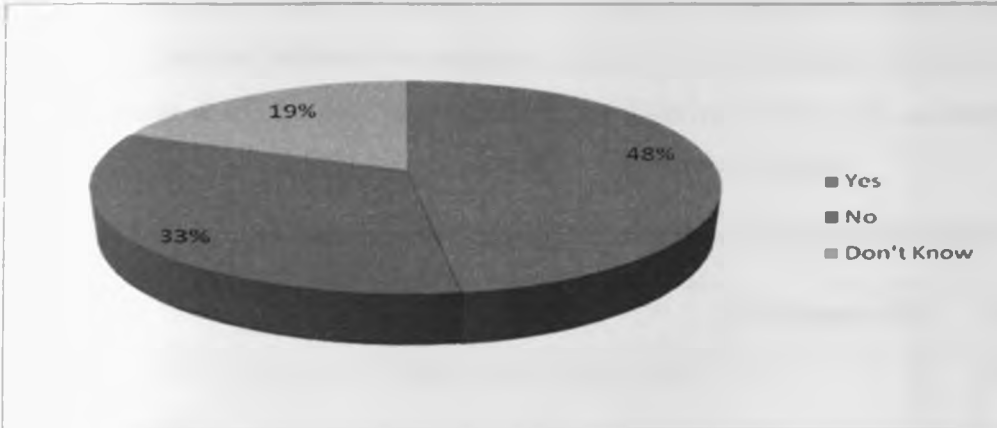
	Frequency	Percent (%)
Minimal	5	23.8
Moderate	9	42.9
Much	5	23.8
Very Much	2	9.5
Total	21	100.0

Table 4 above shows the response as to extent to which the Meteorological Department's rainfall forecasts had assisted KenGen in planning and managing hydropower generation and 43% of the respondents were of the opinion that it had moderately assisted while 24% thought that it had assisted to some extent. Only about 10% thought that it had assisted KenGen very much in planning and managing hydropower generation.

Reservoir Simulation, Modeling and Forecasting

When respondents were asked if KenGen carried out reservoir simulation and modeling in management and planning for hydropower generation, most respondents (48%) said it did and only 33% said it did not. Carrying out of reservoir simulation and modeling was consistent with the observation made by Hamlet et al (2002) that the recent advances in long-lead climate forecasting had made it possible to produce useful stream-flow forecasts for Columbia River thereby improving system operating performance, especially in years of expected above average flows.

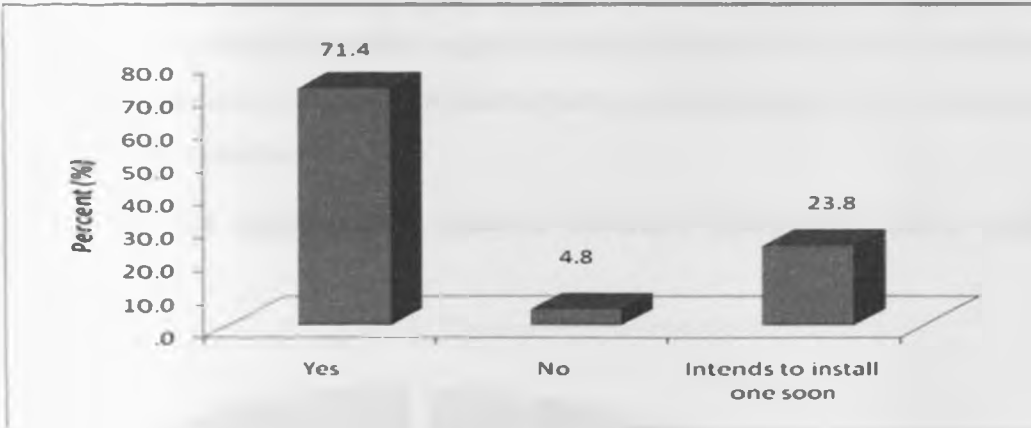
Figure 3: Does KenGen carry out Reservoir Simulation, Modeling and forecasting?



Water management system

Respondents were asked if KenGen had a Water Management System for its hydropower dams. Most of the (71.4%) respondents said it had and about 24% said that it intended to install one soon. See figure 4 below.

Figure 4: Does KenGen have a Water Management System?



Factors that have affected non-implementation of raising the dam level

During good hydrology seasons, the hydro dams on Tana River cascade have spilled excess water. According to the respondents, KenGen had plans to raise Masinga dam's level to

increase its holding capacity. Masinga dam was the largest hydro reservoir and it fed water to other four dams down the River Tana cascade. As indicated in table 5 below, some of the factors that had affected non-implementation of raising the dam level by KenGen were; that Masinga dam was owned by TARDA and KenGen had to seek authority to raise the dam level; lack of funds; social issues and environmental impacts.

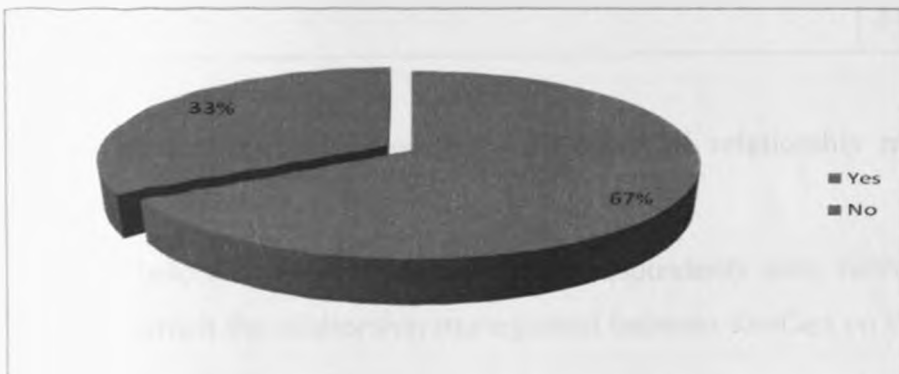
Table 5: Factors that have affected non-implementation of raising the dam level

Factor	Frequency (%)	Percent (%)
Masinga dam is owned by TARDA and Kengen has to seek authority	16	80.0
Lack of funds for the project	9	45.0
Social issues raised by neighboring communities	6	30.0
Environmental impact assessment	6	30.0

Sedimentation of hydropower dams

A total of 67% of the respondents thought that sedimentation/siltation had reduced KenGen’s hydropower dams’ water holding capacities as shown in figure 5 below. This was consistent with observation made by McCully (2000) that investors had looked at dams and found serious operational problems such as sedimentation as one factor impeding on hydropower investment.

Figure 5: Has sedimentation reduced KenGen’s hydropower dam’s water holding capacities?



Dredging of dams to remove sedimentation of soil

When further asked how regularly dams were dredged to remove sedimentation/siltation, 64.3% of the respondents said it was done once every five years as shown in table 6 below.

Table 6: How regularly are dams dredged to remove sedimentation/siltation?

	Frequency	Percent (%)
Once every five years	9	64.3
Never	3	21.4
Only when the dams have no water	2	14.3
Total	14	100.0

4.3.5 Hydropower dams management

From table 7 below, about 57.1% of respondents were of the opinion that the arrangement between KenGen and the regional Development Authorities in the management of these dams was contractual for usage of water to generate power for a fee and 43% of the respondents felt that KenGen had a right to use water freely to generate power.

Table 7: Arrangement between KenGen and the Regional Development Authorities in the management of hydropower dams

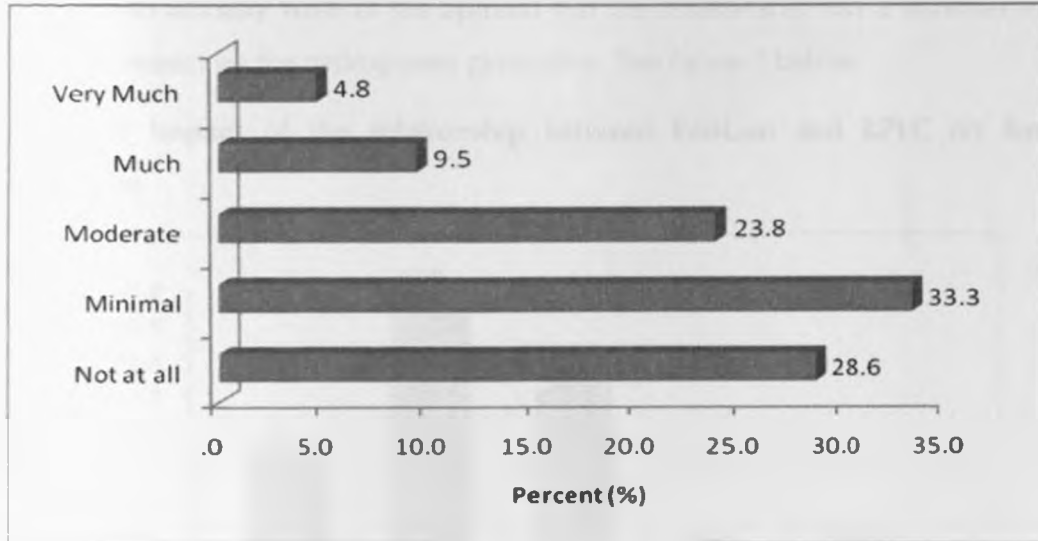
	Frequency	Percent
Contractual for usage of water to generate power for a fee	12	57.1
KenGen has a right to use water freely to generate power	9	42.9
Total	21	100.0

Impact on hydropower generation as a result of relationship management between KenGen and RDAs

Figure 6 below shows the response when respondents were further asked to state the extent to which the relationship management between KenGen on one hand and TARDA

and KVDA on the other had negatively impacted on hydropower generation. Most respondents (33.3%) said that the impact had been minimal while some (28.6%) thought that there was no impact at all.

Figure 6: Impact on hydropower generation.



Impact on hydropower generation with KenGen owning the dams

Table 8 below shows the responses when respondents were asked the extent to which they felt the management of Masinga, Kiambere and Turkwel hydropower dams would improve if KenGen owned them unlike then that they were owned by TARDA and KVDA as seen in the table below. Most respondents thought that the management would improve a lot.

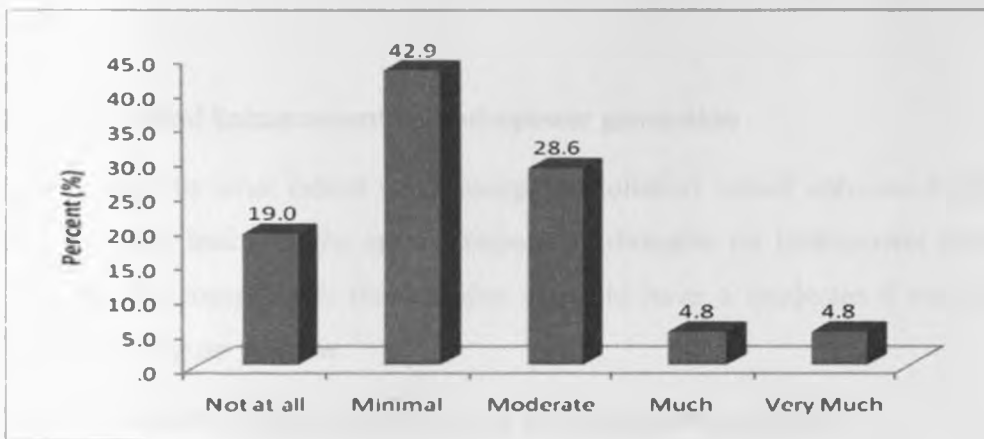
Table 8: Impact of KenGen Dam Ownership

	Frequency	Percent (%)
Not all	1	4.8
Minimal	3	14.3
Moderate	5	23.8
Much	8	38.1
Very Much	4	19.0
Total	21	100.0

Impact of the relationship management between KenGen and KPLC on hydropower generation

The study sought to find out how the relationship management between KenGen and KPLC had negatively impacted on hydropower generation. The results showed that most respondents actually were of the opinion that the relationship had a minimal if not at all negative impact on the hydropower generation. See figure 7 below.

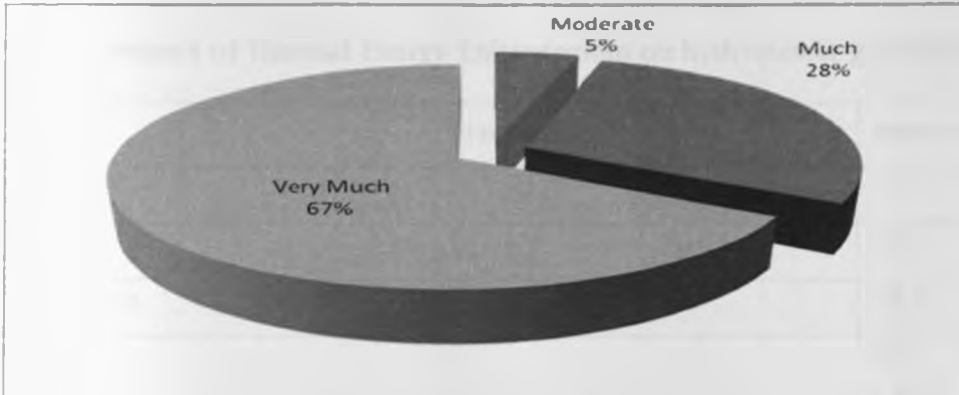
Figure 7: Impact of the relationship between KenGen and KPLC on hydropower generation



4.3.6 Impact of diversification of electric power sources on hydropower generation

Figure 8 below shows respondents views on the impact on hydropower generation to the recent KenGen's focus on more geothermal energy enhancement programme. About 67% of the respondents were of the opinion that this was a good strategy that would lead to mitigating against impacts of drought on hydropower generation to a great extent.

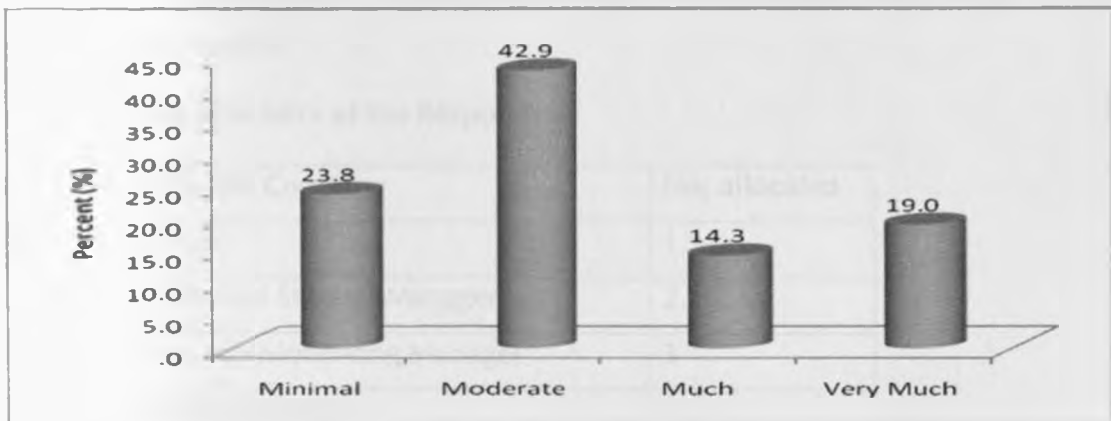
Figure 8: Impact of Geothermal Enhancement on hydropower generation



Impact of Wind Enhancement on hydropower generation

When asked to what extent wind energy exploitation would enhance KenGen’s electric power output and mitigate against impacts of droughts on hydropower generation, most (43%) of the respondents thought that it would have a moderate if not minimal (24%) impact. See figure 9 below.

Figure 9: Impact of Wind Enhancement on hydropower generation



Impact of Thermal Energy Enhancement on hydropower generation

When asked how the construction of the 120MW thermal power plant at Kipevu in Mombasa would impact in mitigating against effects of drought on hydropower generation

in the future, most respondents were of the opinion that this would impact to a great extent on the hydropower generation as shown in table 9 below.

Table 9: Impact of Thermal Energy Enhancement on hydropower generation

	Frequency	Percent (%)
Moderate	9	42.9
Much	6	28.6
Very Much	4	19.0
Minimal	2	9.5
Total	21	100.0

4.4 KenGen's strategies in addressing drought effects on hydropower generation

This section analyses the data and findings based on questionnaire on strategies implemented in addressing the problem of drought effects on hydropower generation.

4.4.1 Characteristics of respondents

The completed responses of second questionnaire were serialized and double checked to ensure quality control.

Table 10: Characteristics of the Respondents

Position held in the Company	No. allocated
Projects Manager	1
Capital Planning and Strategy Manager	2
Transformation and Monitoring Manager	3
Technical Services Manager	4
Special Projects Coordination Manager	5
Clean Development Mechanism Manager	6
Assistant Projects Manager	7

The designations of the respondents were 6 Managers and one Assistant Manager. When asked if there was any plan to balance the current ratio of Hydro, Thermal, Geothermal and Wind energy mix for KenGen at 70%:15%:14%:1% and bearing in mind the cyclic nature of hydrological drought that affects hydropower generation in Kenya, all the respondents answered in the affirmative.

4.5 Balancing the energy portfolio

All the respondents indicated that geothermal resource exploitation was the strategy KenGen had adopted with the short term plan to increase of geothermal energy to about 24% by 2013 and the long term plan to raise geothermal to 50% - 60% of the energy mix.

Factors impacting on developing 600MW of hydropower downstream of Kiambere dam

Respondents were asked why KenGen had not developed the 600MW hydropower capacity, that Ministry of Energy (MOE) Sessional Paper No.4 (2004), on Energy, had indicated as existing downstream of Kiambere dam (7-Forks cascade). Most respondents indicated that lack of funds, poor planning in capacity expansion, environmental and social issues and lack of support from the GOK as major handicaps. However, some respondents indicated that KenGen was in consultation with RDAs to develop at least 200MW of the capacity and others showed that geothermal was a priority as good hydrology was not assured and the long distance transmission of power and the capital involved in developing hydropower was not attractive as an investment.

The observations of the respondents were consistent with those made by McCully (2004) which showed that investors had looked at dams and found high construction costs, serious sedimentation and vulnerability to drought and floods, and long delays due to public opposition as impediments to hydropower development.

Geothermal potential in Kenya

The researcher sought to know why KenGen had only installed 150MW of geothermal energy whereas the MOE Sessional Paper No.4 (2004) on energy had indicated that Kenya

had a potential of over 2,000MW in the Rift Valley region. Most respondents said that the upfront capital cost associated with geothermal resource development, high risk associated with drilling of steam wells and lack of government funding as some of the factors that had made geothermal development stagnate. Some respondents indicated that inertia on part of KenGen may have caused the problem as KenGen had been able to meet National electric power demand and the demand trend only changed in 2005. All the respondents were in agreement that the strategy had now changed towards enhancing the geothermal capacity due to its reliability.

Wind energy harnessing in Kenya

In the recent past, private developers had acquired the rights to generate wind power in Turkana and Marsabit areas and respondents were asked why KenGen did not get the first chance to develop the sites? Some respondents indicated that KenGen's current focus was on geothermal which, had better and assured returns as wind power generation had low load factors due to wind speed variations while others indicated that KenGen had its own 12 wind sites in Marsabit and Turkana where wind data was being collected. Others indicated that private developers had the right to acquire licenses to generate electric power as the electric sub-sector had been liberalized.

4.6 Impact of G2G strategy implementation on KenGen's energy portfolio

The researcher wanted to know how the implementation of Good to Great (G2G) strategy had impacted on hydropower generation enhancement and diversifying KenGen's energy portfolio and most respondents indicated that impacts were positive as the G2G strategy had sought implementation of quick wins in enhancing plant availability in terms of embracing Condition Based Maintenance (CBM) and minimizing operations costs of power plants by scheduling maintenance jobs to be done within working hours and reducing overtime.

Forming strategic alliances with other companies in enhancing electric power capacity

Forming strategic alliances with other companies had been identified to be one way of harnessing synergies and increasing capital for growth in a selected area of operation and the researcher wanted to know to what extent KenGen had ventured into forming strategic alliances with potential investors in the energy sector. Most respondents indicated that KenGen was in advanced stages of forming strategic partnerships; with Daewoo Company in developing a 600MW coal fired thermal power plant in the coastal region, Chemilil Sugar Company in developing co-generation, and Nairobi City Council in developing a thermal power plant fired from the solid waste collected within the city. It was noted that this will draw synergies from such joint ventures and improve KenGen's revenue base.

Capital Markets as an alternative source of financing for power projects

In the recent past KenGen issued an Infrastructure Bond (PIBO) to raise capital to facilitate expansion of its electric power capacity and the researcher sought to know what projects were targeted for expansion and why? Kipevu III 120MW diesel thermal plant, Tana 20MW hydro power plant, 75MW wellheads at Olkaria, raising of Masinga dam level and purchasing of two rigs for drilling geothermal steam wells were indicated as the targeted projects for the PIBO. The reasons given for the projects' preference were that they were quicker to install and stabilize power supply in the short term and feasibility studies were in place.

Maximizing utilization of resources

KenGen was in the process of relocating its 60MW Gas Turbine power plant from Mombasa to Nairobi and the researcher sought to know why there was need to do so and most respondents indicated that this was necessary to displace the expensive emergency power by providing voltage support for the Nairobi area which is the biggest load centre (high power demand area). It was also noted that the Gas turbine plant would alternately generate both active and reactive power with the latter stabilizing the power system and allowing more uptake of hydropower especially during good hydrology periods.

Contracting for emergency power supply during hydrological drought periods

The researcher sought to know whether it was a good strategy for KenGen to enter, on behalf of GOK, into an emergency power supply contract with a private investor to supply electric power as stop-gap measure to fill in the shortfall in capacity supply occasioned by the prolonged drought in 2009 and most respondents were of the opinion that it was a good strategy as not having power at all was more expensive for the economy and KenGen had an obligation to provide the country with an alternative source of electric power during drought periods.

Implementation of a 300MW-600MW of coal thermal power plant

Respondents were asked if the plan by KenGen and the MOE to install between 300MW to 600MW capacity of coal fired thermal plant in the costal region was a good strategy in mitigating the impacts of drought on hydropower generation and most respondents indicated that it would have an impact in the event of a hydrological drought and that coal power generation was cheaper than oil fired generation. It was also noted that coal fired power generation operated at very high load factors and would allow KenGen to develop more geothermal energy with less stress. One respondent noted that though coal power generation was welcome, it also had its attendant problem of contributing to global warming with emission of carbon gases.

Membership to Kyoto Protocol on climate change

The researcher wanted to know if the respondents were aware of the Kyoto Protocol to the United Nations Framework Convention on Climate change and all 7 respondents confirmed being aware. The respondents were also asked if they knew whether Kenya was a signatory to the Kyoto protocol and 5 respondents confirmed knowing while 2 did not know. The researcher further wanted to know if KenGen had received any assistance from CDM under Kyoto Protocol since it had been implementing projects on geothermal, wind and hydropower which were deemed to be projects resulting in certified carbon emission

reductions and normally attracted assistance in arranging for funding under Article 12 of the Kyoto Protocol.

Some respondents indicated that Olkaria 2 Unit 3 which was commissioned in May 2010 was qualified for carbon credit certification and communities neighboring Olkaria geothermal projects would benefit from such funding in community development programmes. KenGen had also made applications to receive CDM funds on several projects like wind energy it had implemented and which reduced carbon emissions.

4.7 Mitigating tools of addressing hydrological drought effects on hydropower generation

The researcher asked the respondents if KenGen had implemented any mitigating tools in dealing with hydrological drought effect on hydropower generation and 6 out of 7 of the respondents were agreeable that indeed mitigating tools were available. When further asked to explain the benefits the tools had brought to KenGen, most respondents indicated that historical data had been used during feasibility studies of new power plants.

Some respondents indicated that tools like Acres Simulation Programme (ASP) had been used to simulate reservoir and hydrological forecast which had assisted KenGen to manage water in the dams. It was also noted that much as KenGen had the tools to manage water in the dams, the MOE, KPLC and ERC had a very big role in deciding the manner in which hydropower plants were dispatched and more so during the drought period and KenGen might not really have managed the water as it would have preferred.

The respondents were asked to give the intervention mechanism employed by KenGen during periods of severe hydrological drought to address the resultant shortfall in power capacity. From the answers provided by the respondents, it was clear that KenGen had sourced for emergency power to meet the shortfall fall in capacity resulting from reduced hydropower generation and also embarked on fast tracking installation of thermal capacity. KenGen was relocating its 60MW Gas Turbine plant from Mombasa to Nairobi which was the load centre with assured dispatch by KPLC.

4.7.1 Factors that have impacted on KenGen's strategy in enhancing geothermal energy

Respondents were asked what the impact of Geothermal Development Company (GDC) would be on KenGen's geothermal energy enhancement as the newly formed government company had been tasked with exploration and development of steam wells and sell the same to KenGen and/or IPPs, a function KenGen had been doing and most respondents were of the opinion that this was a good development as the risk associated with drilling of wells had been offloaded from KenGen and the latter now had better opportunity to concentrate on building geothermal power plants from confirmed production steam wells. Some respondents noted that the loss of highly trained manpower to GDC would negatively impact on KenGen's geothermal enhancement programme as most geothermal scientists who had moved to GDC had taken away with them experience nurtured over a long period and that once GDC developed more steam wells, IPPs could pose a bigger threat to KenGen's dominance in the sector if they secured the steam wells for developing power plants.

Threats posed by IPPs to KenGen's dominance in electric power generation

Respondents were asked what threats IPPs posed to KenGen's dominance as the leader in the electric power generation sector and most respondents were of the opinion that KenGen had its market share reduced from 86% to 75% since 1998. Loss of experienced staff to IPPs was also indicated as threat to KenGen's dominance in the sub-sector.

Government budget allocation to develop renewable energy sources

Electricity consumers in Kenya had severally complained that the cost of fuel from energy generated by the emergency power supply project had made their electricity bills to go up and the researcher sought to know why KenGen could not obtain such budget allocation from the GOK to develop renewable sources of energy.

Most of respondents indicated that KenGen had been receiving budget allocation from the government to develop geothermal and wind resources. Some respondents indicated that funding from the government was not enough and KenGen had been forced to go to

capital markets and development partners for financing with the government providing the guarantees to the financiers. It was also noted that as KenGen was no longer a 100% government owned entity after issuing out a 30% IPO in year 2006 and the government was careful in funding KenGen as stakeholders in the entity had increased and there could arise asset ownership problem.

4.8 Information from KenGen's Business Plan and other documentations (Appendix I)

KenGen Business Plan 2011-2016 had set out an ambitious goal of adding 2,000MW in the next ten years and had branded the journey as "Good-to-Great (G2G) Transformation". The business plan had captured three horizons through which this would be attained, i.e. horizon I which had projects to be implemented between 2008-2013 and add 609.6MW; horizon II projects between 2014-2018 adding 1,955MW and horizon III to be implemented to mitigate the dominant geothermal strategy in Horizon II would install a coal plant phase of 600MW and LNG thermal plant of 300MW-600MW, identified as suitable alternatives to provide base load capacity.

The business plan had identified three key pillars of rigorous capacity expansion programme; regulatory management and operational excellence on which the G2G transformation would be achieved. Timely delivery of projects had been noted as a major factor in realizing company goals of enhancing power capacity and reducing costs by improving efficiency in all KeGen's business processes and in particular procurement of goods, fuels and services.

It was also noted that Kenya had a single-buyer model for the electricity market which was consistent with the observation made by the International Review of Power Reforms Report (2001) and by Eberhard et al (2008) in a study on the state of power sector in the Sub-Saharan Africa as being dominated by single-buyer models. The business plan further indicated that the Energy Act (2006) has allowed for further long-term deregulation in the sector with the envisaged wholesale market and independent system operator.

Key strategic issues

The business plan had specified the key strategic issues in KenGen as; collaboration with GOK and GDC, maintaining emphasis and focus on geothermal resource exploration over the long term in all identified sites; obtaining license for greater Olkaria area to facilitate development of additional 420MW at Olkaria field; acquisition of drilling rigs to fast track the drilling programme and to pursuing strategic partnership in geothermal with private developers particularly in Longonot and Suswa geothermal sites; lobbying Ministry of Regional Development for possible equity participation in power generation in identified multipurpose dam projects and establishing adequate human resource to execute the strategy; acquiring strategic sites identified for geothermal, wind in Marsabit, Isiolo, Ngong' and Kinangop and coal plant at Lamu.

Electricity Pricing and PPAs

The business plan indicated that KenGen had signed five-long term PPAs with KPLC and duly approved by ERC. The PPAs were: Hydro, Geothermal, Kipevu Diesel, Gas Turbine and Off-Grid/Mini Hydro stations. The plant specific two-tier tariff structure comprised of capacity and energy charge.

The hydro PPA had captured the methodology to be used in capacity payment during periods of force majeure, e.g. period when hydrology was poor due to prolonged drought. The PPA clarified that KenGen should receive capacity payment for the part of the plant that remained available during such periods.

Asset Transfer Agreements with RDAs and GOK

It was confirmed that KenGen had signed ATAs with RDAs and GOK which had limited KenGen to only generating power using the water in the Masinga, Kiambere and Turkwel dams. The information found in the ATAs confirmed that the major hydropower dams of Masinga and Kiambere are owned by TARDA and KVDA owns the Turkwel hydropower dam. This confirmed the finding on impacts on hydropower generation objective that one

factor that had impeded on raising the level of Masinga dam in order to increase the water holding capacity was the question of dam ownership.

4.5 Discussions

4.5.1 Strategies implemented in addressing problem of drought on hydropower generation

During data analysis, it was established that KenGen future lies with geothermal energy exploitation and the envisaged ratio of energy mix was expected to relegate hydropower with geothermal constituting about 60% of generation portfolio by year 2018. Most respondents concurred that geothermal was not only abundantly found in Kenya but also does not depend on rainfall. This was consistent with Ansoff (1987) observation that the business environment was constantly changing and making it imperative for organizations to continuously adapt their activities in order to succeed.

Several intervention mechanisms instituted by KenGen for intervention in addressing hydrological drought effects on hydropower generation were indentified and the most significant ones included the provision of emergency power supply on temporary basis, fast tracking the 120MW Kipevu III thermal plant to start generating power by December 2010 and relocating the 60MW Gas Turbine Plant from Mombasa to Nairobi where it was most required to support the load centre. The intervention mechanisms applied to mitigate against effects of drought on hydropower generation were consistent with the observation made by Barroso (2004) when he analyzed the hydrological risk faced by hydropower based markets in Brazil and proposed possible mitigation measure as insertion of a thermal power plant into the portfolio as it diversified the energy mix.

The G2G Transformation Programme that KenGen had been implementing to enhance its electric power capacity and mitigate against hydrological drought effects on hydropower generation was indentified as having a three-phased strategy approach. These strategies were; growth strategy focusing on effective delivery of current power projects, aggressive geothermal expansion over the next ten years to raise installed capacity to 3,501.5MW by

year 2018, and improving capital planning and execution processes; regulatory strategy focusing on improving efficiency of the current single-buyer model, through close collaboration with KPLC, KETRACO and ERC; and productivity strategy focusing on optimizing current maintenance practices by implementing Plant Information System (PIS), the Supervisory Control And Data Acquisition (SCADA), Planned and Condition Based Maintenance, reducing operational and overhead costs in fuel and maintenance work, and improving key processes that impacted on operational effectiveness like procurement of spares.

Inference could be drawn from observations made by NAPA (2006) in a study on the devastating drought (1991/1992) that crippled many sectors of the economies in the riparian states of the Zambezi basin with amongst the worst affected being agriculture and hydroelectric power generation. NAPA (2006) had observed that in order to mitigate the effects of drought on hydropower generation, it was important to strengthen electricity utilities to improve efficiency and financial viability. It was pointed out that it was necessary to have assessment of vulnerability of supply systems, including hydropower and the development of other renewable sources less sensitive to climate, assessment of climate change impacts on demand, support of the expansion and development of regional electricity access and energy efficiency.

These strategies were consistent with the observation made by Foster (2001), that operations strategy was “the total pattern of decisions which shape the long term capabilities of an operation and their contribution to strategy”. He had further argued that a firm’s operations strategy defined how it would compete in its own best way and that the strategies consisted of policies and plan for how to use production resources to meet corporate strategic goals. It could be argued that by KenGen implementing its identified strategies it would be competing in its own best way as observed by Foster.

It was established that KenGen was in advanced stages of forming strategic alliances with Daewoo Company of South Korea in its venture of developing 600MW of coal fired thermal

plant in the coastal region, Chemilil Sugar Company in developing co-generation power from sugar byproduct and partnering with City Council of Nairobi in developing a thermal power plant fired with solid waste collected within the City. Most respondents indicated that the 600MW coal fired power plant to be located in the coastal region would greatly mitigate against the drought effects on hydropower generation as it was cheaper than fossil fuel fired thermal plant and its ability to continuously generate (load factor) was high.

Feurer et al (1995a, b) had indicated that research into strategic planning and dynamic strategy formulation and implementation had become a major focus of academia and industry to improve manufacturing and operations, whereas Mintzberg et al (1998) and Pun (2003) had argued that this was so because with accelerating dynamics of the competition, the key to competitiveness no longer lied in employing strategies that have been successful in the past or emulating the strategies of successful competitors. It can be argued that KenGen's intention to enter into strategic alliances with private investors in the power sector was consistent with above observations and KenGen stood a good chance to survive and enhance its power generation capacity and revenue base by partnering with investors thus drawing synergies and capital to invest on more capacity expansion.

KenGen's issuance of a PIBO in year 2009 to raise capital to fast track its implementation of the 120MW thermal power plant in Mombasa, redevelopment of Tana 20MW hydro plant, installation of geothermal capacity of 75MW wellheads in Olkaria, raising of Masinga dam level and purchase of two geothermal drilling rigs, was indentified as a good strategy. The reasons provided for preference for above selected projects were; it was quicker to implement and stabilize the power supply in the short term.

KenGen had been implementing power generation projects that qualified for carbon credit, e.g. geothermal, wind and hydro power plants. These renewable sources of energy qualified for funding from the CDM under Kyoto Protocol for carbon emission reduction and it was found that KenGen had applied to CDM under Kyoto Protocol for funds after implementing the geothermal 35MW Olkaria 2 Unit III which was commissioned in May 2010 and

communities neighboring Olkaria geothermal project could benefit from such funding in community development programmes. This was identified as a good strategy as it gives incentive to develop more generation capacity that reduces carbon emissions, assists projects' neighboring communities and also addresses the problem of drought on hydropower generation.

KenGen's entry into the capital markets to raise funds and its application to CDM under Kyoto Protocol for funds was consistent with Aosa (1998) observation that in a changing environment, organizations have to constantly adapt their activities and internal configurations to reflect the new external realities and failure to do so may put the future success of the organization in jeopardy.

The entry of GDC in the geothermal exploration and development of steam wells was a good development for KenGen's strategy in geothermal development with the high risk associated with drilling of steam wells having been offloaded from KenGen. This would enable KenGen to concentrate on building geothermal power plants from already confirmed steam production wells.

4.5.2 Underlying factors impacting on hydropower generation

Hydrological drought was found to have seriously affected KenGen's energy output with resultant reduction in energy sales revenue from hydropower. This was consistent with the findings by Cherry et al (2005) that most of hydropower plants in areas affected by droughts suffered from reduced energy production due to lower water levels and experienced great economic losses from poor energy sales.

In trying to address the issue of drought effects on hydropower generation, KenGen had put in place a water management system and used Acres Simulation Programme (ASP) to simulate reservoir and hydrological forecast which could assist KenGen to manage water in the dams. This was consistent with Baykan et al (2006) quoted strategies against drought as; determining the flexibility and vulnerability of hydrologic systems and water management

systems; enhancing system-wide operation; enhancing scientific measurement, monitoring, knowledge and forecasting; and implementation of water conservation measures etc.

The influence of MOE, KPLC and ERC had in deciding the manner in which hydropower plants were dispatched by KPLC during the drought period was indentified as impacting on hydropower generation in KenGen. This was so because much as KenGen had implemented a water management system and adopted forecasting and modeling as tools to assist in management of water in the dams during drought periods, it was not possible for KenGen to really manage the water as it preferred best and this was an impediment to management of hydropower generation by KenGen.

Several factors that had affected non-implementation of raising Masinga dam level were indentified as; lack of funds, social issues and environmental impact; and sedimentation/siltation that have reduced KenGen's hydropower dams' water holding capacities. Most respondents said that the dams are dredged once in every five years to remove sedimentation/siltation. This was consistent with McCully (2000) observation that private investors had looked at dams and found high construction costs, serious operational problems such as sedimentation and vulnerability to drought and floods, and long delays due to public opposition as impediments in hydropower capacity expansion and Tumbare (2008) had observed that social and environmental issues were a problem experienced when Kariba dam was built when the Tonga/Korekore people were displaced on both banks of Zambezi River and they felt short-changed as they were not adequately compensated.

It was also important to note that Braga (2001) in his study on hydropower in Brazil had noted that significant lowering of water levels in the reservoirs of many Brazilian hydroelectric power plants was attributed to the severe drought. Braga (2001) noted that the federal government was forced to announce power rationing plan to avoid blackouts from June till the onset of the rainy season (late October, early November). Braga (2001) indicated that by September 2001 the reservoirs were working at minimum capacity (about

20 percent of the total volume), and that was evidence of the failure of existing energy and water resources management plans to meet unexpected shortages. By drawing inference from Braga's observation and relating to the fact that the study had indentified that the MOE, KPLC and ERC had a bigger say on how KenGen managed water in the hydro dams during drought periods, it was possible evidence of failure of existing energy and water resources management plans to meet unexpected shortages in Kenya.

Several factors were identified as having limited KenGen's geothermal capacity to 150MW out of a possible 2,000MW, these were; upfront capital cost associated with geothermal development; high risk in steam wells' drilling; inertia on part of KenGen as previously the firm had been able to sustain the country with electricity; and lack of enough government funding. The study also identified that the loss of highly trained geothermal development scientists to GDC was a major drawback to KenGen's geothermal strategy in mitigating effects of drought on hydropower generation as it takes many years to develop the human resource capital required for geothermal development.

It was established that the relationship management between KenGen and its customers, the RDAs and KPLC had no major impact on hydropower generation by KenGen as 85.7% and 90.5% of respondents, respectively believed the the relationship had little impact.

CHAPTER FIVE: SUMMARY, CONCLUSIONS, RECOMMENDATIONS, LIMITATIONS AND SUGGESTIONS

5.1 Summary

The purpose of the case study was to identify; the operations strategies KenGen management had put in place in addressing the problem of drought effects on hydropower generation and the underlying factors that impacted on hydropower generation. Primary data was gathered through administering of two questionnaires based on the objectives of the study. The first questionnaire dealt on factors that impacted on hydropower generation in KenGen while the second questionnaire dealt with strategies that KenGen had put in place in addressing the effects of drought on hydropower generation in KenGen. The Business Plan, PPAs and the ATAs were used for mining secondary data.

5.2 Conclusions

Operations Strategies

KenGen's strategy of contracting a private firm to generate emergency power as a stopgap measure to fill in for capacity shortfall during drought period was indentified as good. Though the emergency power was costly, it was found to be necessary as having no power at all was even more expensive for the economy. This was consistent with observation made by GSA (2006) that virtually all sectors of society, the economy, and the environment were vulnerable to impacts from drought with resultant; reduced water flows that reduced the amount of power generated and the revenues of the industry; increased costs associated with purchasing replacement power; and increasing electricity rates for the customer.

In trying to mitigate the effects of drought on hydropower generation and provide short term solutions, KenGen's issuance of PIBO in year 2009 to raise capital to facilitate fast tracking implementation of the 120MW thermal power plant in Mombasa, redevelopment of Tana 20MW hydro plant, installation of geothermal capacity of 75MW wellheads in Olkaria, raising of Masinga dam level and purchase of two geothermal drilling rigs was indentified as

a good strategy. The reasons provided for preference for above selected projects were; it was quicker to implement and stabilize the power supply in the short term.

The relocation of the 60MW Gas Turbine plant from Mombasa to Nairobi, which had been identified as the biggest load centre (concentration of power demand), was found to be a good operational strategy as the Gas Turbine was guaranteed of dispatch and the plant would be contracted to generate both active and reactive power both of which would generate revenue for KenGen. The reactive power stabilizes the power grid (voltages) to allow more uptake of active power, especially hydropower during good hydrology periods which would tremendously reduce spillage of water.

Hayes and Upton (1988) concluded that for a firm to have a positioning advantage over its competitors, it must begin with decision as to how it wants to differentiate itself in its chosen market place. Inference can be drawn from this observation and concluded that KenGen's intention to forming strategic alliances with; Daewoo Company to develop 600MW of coal thermal plant in coastal region; Chemilil Sugar Company to develop Cogeneration power plant to use sugar byproduct; Nairobi City Council to develop a thermal power plant in Nairobi fired with solid waste collected within the City, was key in differentiating itself in its chosen market place.

The strategy KenGen had adopted of implementing power projects that met the threshold of CDM under Kyoto Protocol and qualify for funding as result of reducing carbon emissions, was good as it would increase geothermal and wind energy capacities.

Factors impacting on hydropower generation

The single-buyer electricity market model was found to be a hindrance to hydropower generation in Kenya as it does not allow KenGen to directly sell power to a few selected big customers at better negotiated tariffs. The introduction of wholesale market model was identified as the best solution to the problem as it would allow KenGen to directly sell its power to a few big selected customers at better negotiated tariffs and get good returns on

its investments to enable it expand its power generation capacity. This was consistent with the observation made in the International Review of Power Reforms Report (2001) that Thailand government intended to introduce the wholesale competition model which involved competition in the market that generally required some form of spot market and direct competition among generators for sales. This arrangement allows a limited set of customers, generally the largest customers in the market, who could choose their supplier.

Braga (2001) had noted during the severe drought in Brazil in 2001, the reservoirs were working at minimum capacity (about 20 percent of the total volume) and that was evidence of the failure of existing energy and water resources management plans to meet unexpected power shortages. Inference can be drawn from Braga (2001) observation that the influence MOE, KPLC and ERC had on how KenGen managed water in the hydropower dams, especially during drought periods as possible evidence of failure of existing energy and water resources management plans in Kenya.

Several underlying factors were identified as having impacted on management of hydropower generation, these were; non-implementation of raising of Masinga dam level to increase its capacity, lack of funds, inertia in planning for capacity expansion, environmental and social issues associated with displacement of people, lack of government funding and influence of MOE, KPLC and ERC in deciding the manner in which hydropower plants were dispatched, more so, during hydrological drought periods.

It was found that the loss of highly trained geothermal development scientists to GDC was a major drawback to KenGen's geothermal strategy in mitigating effects of drought on hydropower generation as it took many years to develop the human resource capital required for geothermal development.

KenGen was found to have been implementing strategies that that would mitigate the effects of drought on hydropower generation and several factors were identified to have

impacted on hydropower generation in KenGen (Kenya). Thus, the objectives of the study were achieved and the study findings have contributed to body of knowledge.

5.3 Recommendations

It was recommended that KenGen vigorously lobbies for further unbundling of the single-buyer model of electricity market with the aim of implementing the wholesale market model which would allow it limited direct selling of electricity to a few big customers at better negotiated tariffs. This would assure KenGen better returns on its investments and give it a firm financial position to develop more power capacity.

KPLC should strengthen its power grid system, especially in the main load centre of Nairobi, to allow more uptake of hydropower during the periods of good hydrology to overcome spillage of water.

The GOK should give more incentives to investors of renewable energy sources like wind and geothermal in order to overcome the problem of drought on hydropower generation in Kenya.

5.4 Limitations of study

One limitation of the study was the non-responsiveness of one manager on the second questionnaire on strategy. This reduced the size of sample to seven and it would have been more enlightening if a larger sample was used for the qualitative analysis. In the first questionnaire on hydropower generation, it was noted that 67% of respondents thought that sedimentation had reduced KenGen dams' capacities to hold water whereas 64.3% indicated that dredging of the dams to remove sedimentation of soil was carried out every five years. The study was limited in affirming the same from documentations that were availed as per Appendix I.

5.5 Suggestions for further research

Several researches have been done and documented on effects of hydrological drought on hydropower generation in USA, Brazil, Asia and other parts Africa but none seems to have been done in Kenya. This had denied potential key investors a source of information on what factors to consider for successful implementation of hydropower projects.

Further research was recommended on effects of; sedimentation on dams' water holding capacities; water evaporation as dams are located in the semi-arid regions of Kenya; the impact of reduced water runoff and infiltration to rivers feeding the hydropower dams due to human activities in the rain catchment areas. This would be in line with Jenkins et al (2002) and Marengo et al (2002) observation that the increase in observed global temperatures was consistent with an increase in evaporative rate, a decrease in runoff production, and thus reduction of surface water inputs to hydroelectric reservoirs.

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Appendix I: Documentations

	Documentation Description	Information Available
1	Kengen Business Plan	<ul style="list-style-type: none"> i. Business strategy on meeting the rising demand for electricity and mitigating the effects of hydrological drought on hydropower generation ii. Corporate goals and major initiatives iii. Key Strategic issues iv. Core values v. Internal and external environments
2	Power Purchase Agreements with KPLC	<ul style="list-style-type: none"> i. Operating and dispatch procedures ii. Sale and purchase of electricity iii. Undertakings and warranties iv. Dispute resolution
3	Assets Transfer Agreements	<ul style="list-style-type: none"> i. Conditions precedent ii. Transfer of assets and liabilities iii. General conditions of transfer of assets and liabilities iv. Undertakings and warranties

Appendix II: Interview Guide Questionnaires

The questionnaire has been designed to collect information from senior management staff of KenGen for academic purposes only. Please complete each section as instructed. The information will be treated in confidence.

SECTION I: HYDROPOWER GENERATION IN KENGEN

1. Position held in the company: _____

(Please tick or mark with "X" as appropriate)

2. How long have you worked in KenGen?

(a) 1 to 3 years

(b) 3 to 5 years

(c) 5 to 10 years

(d) 10 years and above

3. About 70 percent of KenGen's power generation consists of hydropower, is this good strategy for the company?

(a) Yes, hydropower power is cheaper for the country and always available

(b) No, KenGen needs to invest more in other energy sources

4. Does the current Hydro Power Purchase Agreement between KenGen and KPLC guarantee hydro power generation as a base load?

(a) Yes

(b) No

(c) I don't know

5. Kenya has occasionally experienced cyclic hydrological droughts over the years; kindly indicate the extent to which this has negatively affected KenGen's energy sale revenue from hydropower generation.

Impact	Not at all (1)	Minimal (2)	Moderate (3)	Much (4)	Very Much (5)
Hydropower sale revenue					

6. Please indicate the extent to which the Meteorological Department's rainfall forecasts have assisted KenGen in planning and managing hydropower generation.

Impact	Not at all (1)	Minimal (2)	Moderate (3)	Much (4)	Very Much (5)
Rain forecasts					

7. Does KenGen carry out Reservoir Simulation, Modeling and forecasting in management and planning for hydropower generation?

(a) Yes

(b) No

(c) I don't know

8. Does KenGen have a Water Management System for its hydropower dams?

(a) Yes

(b) No

(c) Intends to install one soon

9. How does KPLC dispatch KenGen’s hydro plants in terms of electric power demand on a daily basis? (can pick more than one)

Hydropower Dispatch	Tick
Full dispatch all day	
Full dispatch only at peak times	
KPLC prefers to fully dispatch IPPS	
KPLC balances dispatch for all modes of power	
KPLC dispatches power plants randomly	

10. How does KPLC dispatch hydro plants during periods of good hydrology to avoid spillage of water in the hydropower dams? (can pick more than one)

Hydro Plants dispatch during good hydrology periods	Tick
Full dispatch to maximize on excess water and cheap hydropower	
Full dispatch during peak times only	
Dispatch balanced between thermal, IPPs and hydro	
Dispatch depends on load configuration in load centres	
Dispatch is random	

11. During good hydrology seasons, the hydro dams on Tana River cascade have spilled excess water, has there been any plan by KenGen to raise Masinga dams' level to increase holding capacity?

(a) Yes

(b) No

12. If yes to above question, kindly indicate which of the below given factors may have affected non-implementation of raising the dam level. (can tick more than one)

Factors	Tick
Masinga dam is owned by TARDA and KenGen has to seek authority	
Lack of funds for the project	
Social issues raised by neighboring communities	
The dam must be emptied before raising the wall	
Environmental Impact Assessment Issues and NEMA approval	

13. Do you think sedimentation/siltation has reduced KenGen hydropower dams' water holding capacities?

(a) Yes

(b) No

14. If yes to above question, kindly indicate how regularly the dams are dredged to remove sedimentation/siltation.

Frequency	Tick
Once in a year	
Once every two years	
Only when the dams have no water	
Once every five years	
Never	

15. TARDA and KVDA Regional Development Authorities own some of the hydropower dams, which of the following describes the arrangement between KenGen and the Regional Development Authorities in management of the dams?

(a) Contractual for usage of water to generate power at a fee

(b) KenGen has a right to use water freely to generate power

16. Please indicate the extent to which the relationship management between KenGen on one hand and TARDA and KVDA on the other has negatively impacted on hydropower generation.

Impact	Not at all (1)	Minimal (2)	Moderate (3)	Much (4)	Very Much (5)
Relationship management					

17. Please indicate to what extent the management of Masinga, Kiambere and Turkwel hydropower dams would improve if KenGen owned them unlike now that they are owned by TARDA and KVDA.

Improvement	Not at all (1)	Minimal (2)	Moderate (3)	Much (4)	Very Much (5)
KenGen Dam Ownership					

18. Kindly indicate how the relationship management between KenGen and KPLC has negatively impacted on hydropower generation.

Impact	Not at all (1)	Minimal (2)	Moderate (3)	Much (4)	Very Much (5)
Relationship management					

19. In the last few years, KenGen has focused on more geothermal energy enhancement; kindly indicate to what extent this is a good strategy in mitigating against impacts of drought on hydropower generation.

Impact	Not at all (1)	Minimal (2)	Moderate (3)	Much (4)	Very Much (5)
Geothermal enhancement					

20. Kindly indicate to what extent increased wind energy exploitation will enhance KenGen's electric power output and mitigate against impacts of drought on hydropower generation.

Impact	Not at all	Minimal	Moderate	Much	Very Much
	(1)	(2)	(3)	(4)	(5)
Wind energy enhancement					

21. KenGen has been constructing a 120MW thermal power plant at Kipevu, in Mombasa; please indicate to what extent this will mitigate against effects of drought on hydropower generation in the future.

Impact	Not at all	Minimal	Moderate	Much	Very Much
	(1)	(2)	(3)	(4)	(5)
Thermal energy enhancement					

SECTION II: IMPLEMENTATION OF ELECTRIC POWER GENERATION STRATEGY

The questionnaire has been designed to collect information from senior managers of KenGen for academic purposes only and modeled on written answers to questions. The information will be treated in confidence.

Kindly answer the questions as succinctly as possible.

1. The approximate ratio of Hydro, Thermal, Geothermal and Wind energy mix for KenGen is 70%:15%:14%:1%. Bearing in mind the cyclic nature of hydrological drought that affects hydropower generation in Kenya, is there any plan to balance the ratio in the near future? Yes No . Kindly explain your answer.

2. KenGen hydropower capacity has been severely affected by drought over the years; briefly give the intervention mechanisms that KenGen has put in place so as to address the resultant shortfall in electric power capacity.

3. In the Ministry of Energy (MOE) Sessional Paper No.4 (2004), on Energy, it is indicated that there is more hydropower potential of over 600MW downstream of Kiambere dam (7-Forks cascade), why has KenGen not developed the 600MW hydropower capacity?

4. Some of the established mitigating tools in dealing with hydrological drought effect on hydropower generation are simulation of reservoir in drought situation and forecasting, has KenGen implemented such tools in its hydro dams' water management?

Yes No . If yes, kindly explain what benefits the tools have brought to KenGen. If No, kindly explain why or what other tools have been employed.

5. The Ministry of Energy (MOE) Sessional Paper No.4 (2004), on Energy indicates that Kenya has a potential of over 2,000MW of geothermal energy in the Rift Valley region; KenGen has only exploited 150MW of it, why?

6. The Government of Kenya recently formed the Geothermal Development Company (GDC) to carry out geothermal exploration and development of steam wells (and sell the wells to KenGen and/or IPPs), a function that KenGen had been doing before; how has this impacted on KenGen's geothermal energy enhancement

programme?

7. In the last two years, KenGen has been implementing the Good to Great (G2G) strategy; what has been the impact of it on?

(a) Hydropower generation enhancement.

(b) Diversifying KenGen's energy mix basket.

8. In your own opinion, what do you perceive as the KenGen's energy mix ratio in the next 5 to 10 years?

9. What is KenGen's plan for expansion of wind energy harnessing?

10. In the recent past, private developers have acquired the rights to generate wind power in Turkana and Marsabit areas; why did KenGen not get the first chance to develop _____ the _____ sites?

11. How much of wind power does KenGen hope to install in the next 5 to 10 years?

12. What threats have the Independent Power Producers (IPPs) posed to KenGen's dominance as the leader in electric power generation in Kenya?

13. KenGen entered, on behalf of GOK, into an emergency power supply agreement with Aggreko International Projects Ltd to generate electric power as a stop-gap measure to fill in the shortfall in capacity supply occasioned by the prolonged drought in 2009; was this good strategy for Kengen? Yes No .

Kindly explain you answer.

14. Electricity consumers in Kenya have severally complained that the cost of fuel from energy generated by the emergency power supply project has made their electricity bills to go up; why can't KenGen obtain such budget allocation from the GOK to develop renewable sources of energy?

15. In the last few years, KenGen has focused more on geothermal, wind and thermal sources of electric power in terms of capacity enhancement, has this been a good strategy for the company in addressing the negative impacts of drought on hydropower generation? Yes No . Kindly explain your answer.

16. Forming strategic alliances with other companies has been found to be one way of harnessing synergies and increasing capital for growth in a selected area of operation; to what extent has KenGen ventured into strategic alliances. Kindly explain and give any examples.

17. Recently KenGen issued an Infrastructure Bond (PIBO) to raise capital to facilitate expansion of its electric power capacity; please explain what projects were targeted for expansion and why?

18. KenGen is in the process of relocating its 60MW Gas Turbine Plant from Kipevu to Embakasi in Nairobi; kindly explain the need to do so.

19. In the recent past, KenGen and the MOE reported that there were plans to install between 300MW to 600MW electric power capacity of coal fired Steam Turbines in the costal region; kindly explain how this is a good strategy in mitigating the impacts of drought on hydropower generation.

20. Are you aware of the Kyoto Protocol to the United Nations Framework Convention on Climate change? Yes . No . If yes kindly proceed to the next question.

21. Under Article 12 of the Kyoto Protocol, on Clean Development Mechanism (CDM), parties (countries) implementing projects resulting in certified carbon emission reductions shall be assisted in arranging funding of certified project activities as necessary. Is Kenya a signatory to the Kyoto Protocol? Yes . No . If yes, kindly proceed to the next question.

22. KenGen has been implementing projects on geothermal, wind and hydropower enhancement; kindly explain if there has been any assistance to KenGen from CDM under Kyoto Protocol, assisting in arranging for funding of such certified projects.
