CHALLENGES HINDERING THE EXPLOITATION OF GEOTHERMAL POWER IN KENYA

Nechenje, C., & Ngugi, P. K.

The Strategic JOURNAL of Business & Change MANAGEMENT
ISSN: 2312-9492 www.strategicjournals.com
Vol. 5, Iss. 3, pp 316 - 331, July 28, 2018. www.strategicjournals.com, ©strategic Journals

CHALLENGES HINDERING THE EXPLOITATION OF GEOTHERMAL POWER IN KENYA

Nechenje, C.,[*1] & Ngugi, P. K.[2]

[*1] EMBA Candidate, Jomo Kenyatta University of Agriculture and Technology [JKUAT], Nairobi, Kenya

[2] PhD., Jomo Kenyatta University of Agriculture and Technology [JKUAT], Nairobi, Kenya

Accepted: June 20, 2018

ABSTRACT

The study sought to establish the challenges influencing the exploitationof geothermal power in Kenya. On the surface of the earth, the use of geothermal hot springs has been known since ancient times but active geothermal exploration for industrial purposes started at the beginning of the 19th century. Specifically, the study sought to establish how capital costs, shortage of local geothermal energy expertise, infrastructure development, existing legal policies and regulatory framework and of land access rights on the the exploitation of geothermal power in Kenya. This study was carried out through a descriptive research method. The study population consisted of the top, middle and lower level managers at Menengai Geothermal Power Project. Stratified proportionate random sampling technique was used to select the sample of 66 respondents (40% of the population). The study used a questionnaire to collect primary data. The pilot testing was conducted using the questionnaire on 10 respondents. The data was then coded and checked for any errors and omissions. Responses in the questionnaires were tabulated, coded and processed by use of a computer Statistical Package for Social Science (SPSS) programme to analyze the data. The study found out that to a great extent that capital cost affected exploitation of geothermal power in Kenya. Additionally the study found out that Geothermal Energy Experts influence the exploitation of geothermal power in Kenya. The study found out that to a very great extent, Legal and Regulatory Framework affected exploitation of geothermal power in Kenya. The study findings showed that Land Rights influence the exploitation of geothermal power in Kenya. From the findings, infrastructural Development influences the exploitation of geothermal power in Kenya. The transmissivity, i.e. the product of thickness and permeability of the aquifer, should be sufficient to permit a production of several thousands of cubic metres per day. It is the main risk factor and often the reason that potential aquifers and locations turn out to be unsuitable.

Keywords: *Capital Costs, Geothermal Energy Expertise, Infrastructure Development, Legal Policies, Regulatory Framework, Land Access Rights*

INTRODUCTION

The world´s major governments have put their emphasis on renewable energy and a transformation to a low carbon economy. At the same time, this could be seen as a significant contribution when it comes to fighting climate change (European Wind Energy Association, 2011).Moreover; renewable energy sources have been used as an alternative to these limited resources and add to the sustainability of future energy supply. Geothermal energy is no exception in this regard. In light of growing demand for fossil fuels, concerns were raised over future supply, which in turn caused their Policies, Legal & Regulatory environments to increase substantially. This development was reflected in the share performance of publicly listed renewable energy companies, where investors saw potential for high growth as the renewable energy was the fastest growing sector producing energy. When the financial crisis struck the world economy in 2008, equity markets worldwide suffered a huge loss, but have since then recovered most of what they lost. This recovery does not seem to have passed through to the renewable energy stocks, which reached a high in the first part of2008. The geothermal energy sector seemed to be recovering as it outperformed wind and solar stocks in 2009, but ever since, geothermal energy stocks have been rapidly declining. Since the start of 2009, geothermal stocks have lost value of around 60percent on average, while the wind and solar stocks are down 22 percent and 44 percent respectively (Íslandsbanki 2011; RÚV 2011). Through the Kenya Vision 2030 policy, economic transformation is envisioned with plans to expand the energy sector through clean renewable options such as geothermal energy in bid to meet the current and future energy demand (Republic of Kenya, 2007). Geothermal prospects in the country occur mainly within the Rift Valley where wide spread volcanic activity and geothermal manifestations signify the existence of geothermal resources, with an estimated potential of between 7000MW to 10,000MW (Simiyu, 2010). Kenya is the first country in Sub-Sahara Africa to significantly exploit geothermal energy; it has also the highest level of geothermal installed capacity of 121 MW (MOE, 2003a).

The Geothermal Development Company (GDC) is a 100% state-owned company, formed by the Government of Kenya as a Special Purpose Vehicle to fast track the development of geothermal resources in the country. Geothermal energy is an indigenous, abundant, reliable and environmentally- friendly source of electricity. The creation of GDC was based on the government's policy on energy - Sessional paper No. 4 of 2004, and the energy Act No.12 of 2006 - which un-bundled the key players in the electricity sector to ensure efficiency. GDC will drill 1400 steam wells to provide steam for the generation of 5,000MW of geothermal power by 2030 (GDC, 2013).

GDC offers the following services to a range of clients which include: geothermal drilling; well testing and logging; geothermal reservoir assessment and management; geothermal resource exploration; provision of steam for electricity generation; promotion of alternative uses of geothermal energy other than electricity generation; and consultancy on geothermal development. More than 14 high temperature potential sites occur along the Kenyan Rift Valley with an estimated potential of more than 15,000 MW. Other locations include: Homa Hills in Nyanza, Mwananyamala at the Coast and Nyambene Ridges. These prospects are at different stages of development (GDC, 2013).

Statement of the Problem

Geothermal energy exploitation in Kenya has been primarily for electricity generation and it constitutes

14% of the country's electricity (GDC, 2013). KenGen generates 89% of this energy from two power plants. Olkaria I power plant was commissioned in the year 1981 while Olkaria II was commissioned in the year 2003. Drilling for a third power plant, Olkaria IV is currently ongoing for a 140 MW power plant. Kenya is currently generating 48 MW 12 MW from an Ormat binary plant commissioned in the year 2000 and 36 MW is from a single flash plant commissioned in 2009. Oserian Development Company, (Oserian), constructed a 1.8 MW binary plant Ormat OEC in 2004 and 2MW from a back pressure turbine commissioned in 2007. Both of these plant use wells leased from KenGen (Knight, 2005).Without access to energy to cook, heat the home, earn a living and fully benefit from health, education and cultural opportunities, whole communities are forced to live on the margins of society (Fridleifsson, 2003). One major challenge for investors has been high upfront risks and enormous capital investment. Hence, there is need for a research that will attempt to determine the challenges influencing the slow exploitation and development of geothermal power in Kenya.

A number of studies written on geothermal power are more general or have failed to give detailed insights on the challenges influencing fully exploitation of geothermal power in Kenya. This study intended to bridge this gap in knowledge. The numerous studies while shedding so much light on geothermal power have not covered the challenges influencing the exploitation of geothermal power in Kenya. To address this gap in knowledge and address the time variance there was indeed a need for a study on the same. This prompted this study on the challenges influencing the exploitation of geothermal power in Kenya.

Objectives of the Study

The main objective of this research study was to establish the challenges hindering the exploitation of geothermal power in Kenya. The specific objectives were:

- To find out how capital costs has affected the exploitation of geothermal power in Kenya.
- To determine the effect of technical expertise on the exploitation of geothermal power in Kenya
- To determine the effect of infrastructural development on the exploitation of geothermal power in Kenya
- To establish the effect of existing legal and regulatory framework on the exploitation of geothermal power in Kenya
- To determine the effect of land registrations on the exploitation of geothermal power in Kenya

LITERATURE REVIEW

Theoretical Review

Transaction Cost Economics theory

While the RBV suggests value creation through resource synergy, Agility in a supply chain can also be achieved by efficient coordination. This can be understood through the lens of transaction cost economics (TCE). Explicitly recognizing the costs of coordination among economic entities in markets, TCE stresses that a firm's central task is to coordinate transactions efficiently (Williamson, 2005). IT can lower coordination costs, and in supply chain contexts, digitally enabled integration capability can substantially improve transactional efficiencies through increased information sharing and communications capabilities, resulting in improved supply chain agility. Furthermore, TCE sheds light on the role of the digitally enabled SCM in competitive environments.

An important feature of a competitive environment is the extensive competitive actions in the markets, such as competitive entry, Policies, Legal & Regulatory environment change, supplier alliances, and new product introduction (Ferrier, 2001). To

improve performance or even survive in competitive environments, a firm needs to adapt its businesses to respond quickly to competitive actions (Sambamurthy et al. 2003). If a manufacturer's operation is frequently affected by competitors' actions, it may face greater needs to coordinate with supply chain partners. For example, a manufacturer that needs to modify the design of its product, because of market entry or new products launched by competitors, also needs to modify the design of upstream components that constitute the product; it may also need to rearrange downstream channels for new product distribution. These may induce considerable coordination tasks (Williamson, 2005). Accordingly, technologies that help reduce coordination costs are more valuable in intensely competitive markets.

Logistics Theory

Logistics is defined as the planning, organization, and control of all activities in the material flow, from raw material until final consumption and reverse flows of the manufactured product, with the aim of satisfying the customer's and other interest party's needs and wishes i.e., to provide a good customer service, low cost, low tied-up capital and small environmental consequences (Jonsson & Mattsson, 2005). Logistics is also defined as those activities that relate to receiving the right product or service in the right quantity, in the right quality, in the right place, at the right time, delivering to the right customer, and doing this at the right cost.

In most of the cases logistics is seen from the perspective of an operative way of transporting or moving materials from one point to another or producing service. The credibility of this operation is based on how good is the design of the system that leads to this kind of logistics. Logistics systems encompass operative responsibilities, which include administration, operation and purchase and constructive duties as well as detailed design, (Lumsden, 2003).

Logistics management is that part of procurement management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services, and related information between the point of origin and the point of consumption in order to meet customer's requirements. Logistics management activities typically include inbound and outbound transportation management, fleet management, warehousing, materials handling, order fulfillment, logistics network design, inventory management, supply or demand planning, and management of third party logistics services providers. To varying degrees, the logistics function also includes sourcing and procurement, production planning and scheduling, packaging and assembly, and customer service. It is involved in all levels of planning and execution strategic, operational, and tactical. Logistics management is an integrating function which coordinates and optimizes all logistics activities, as well as integrates logistics activities with other functions, including marketing, sales, manufacturing, finance, and information technology, (Van Hoek et al., 2001)

Innovation Diffusion Theory

The Innovation diffusion theory is a model grounded in business study. Since 1940's the social scientists coined the terms diffusion and diffusion theory (Dean, 2004). This theory provides a framework with which we can make predictions for the time period that is necessary for a technology to be accepted. Constructs are the characteristics of the new technology, the communication networks and the characteristics of the adopters. We can see innovation diffusion as a set of four basic elements: the innovation, the time, the communication process and the social system. Here, the concept of a new idea is passed from one member of a social system to another. Clemons, (1992) redefined a number of constructs for use to examine individual

technology acceptance such as relative advantage, ease of use, image, compatibility and results demonstrability.The advantage of the improved system is that it has allowed for better communication between the banks since they have to communicate to ensure that less time is taken to realize value on the cheques.

Contingency Theory

Classical and neoclassical theorists viewed conflict as something to be avoided because it interfered with equilibrium. Contingency theorists view conflict as inescapable, but manageable. Chandler (1962) studied four large United States corporations and proposed that an organization would naturally evolve to meet the needs of its strategy -- that form follows function. Implicit in Chandler's ideas was that organizations would act in a rational, sequential, and linear manner to adapt to changes in the environment. Effectiveness was a function of management's ability to adapt to environmental changes.

Lawrence and Lorsch (1969) also studied how organizations adjusted to fit their environment. In highly volatile industries, they noted the importance of giving managers at all levels the authority to make decisions over their domain. Managers would be free to make decisions contingent on the current situation.

Conceptual Framework

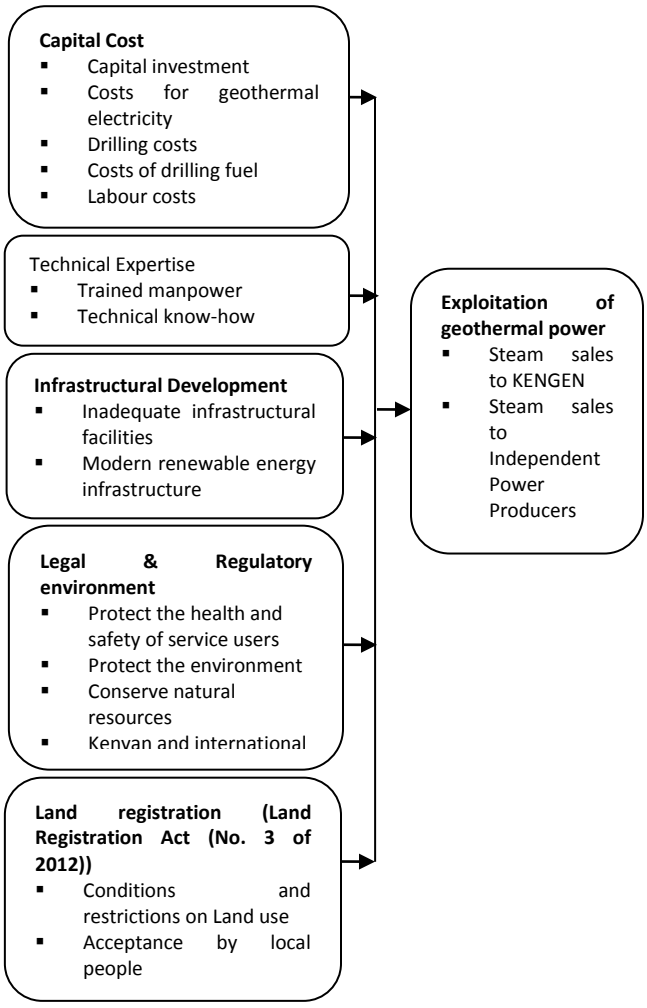

Figure 1: Conceptual Framework

Review of Critical Literature

Policies, Legal & Regulatory environment

In Kenya there are several Acts of Parliament that work together to regulate and guide geothermal and natural resource use in a sustainable manner. Two laws, which specifically deal with geothermal development, are the Geothermal Resources Act of 1982 and supplementary legislation of 1990 and the Environmental Management and Co-ordination Act (EMCA) of 1999. Other regulations do not directly refer to geothermal but due to their implications

affect geothermal development at various stages and in various ways. These include among others Electric Power Act, Forest Act, Water Act, Factories and Other Places of Work Act, Wildlife Conservation and Management Act. Besides these legislations, there are Kenyan and international policies and regulations that govern the development of geothermal resources, more especially those tied to conditions on funding geothermal projects, for example the World Bank operational directive OP 4.00. Initially, KenGen based its environmental management initiatives on the World Bank's operational directive OP 4.00 for the development of Olkaria II.

Capital Cost

The prospects for technical improvements indicate that there is potential for cost reductions in the near and longer term for both conventional geothermal technology and EGS. Additionally, the future costs for geothermal electricity are likely to vary widely because future deployment will include an increasing percentage of unconventional development types, such as EGS. The following estimates are based on possible cost reductions from design changes and technical advancements, relying solely on expert knowledge of the geothermal process value chain. Published learning curve studies for geothermal are limited, so the other major approach to forecasting future costs, extrapolating from historical learning rates, is not pursued here for a more complete discussion of learning curves, including their advantages and limitations.

Technical Expertise

The introduction of unfamiliar technologies such as RETs requires the development of technical skills. The importance of technical know-how in the increased utilization of RETs has been recognized in the region, but in spite of efforts by governments, there is a continuing shortage of qualified personnel (Baguant and Manrakhan, 1994). Technical knowledge is important in order to build over the long term, a critical mass of professional African policy analysts, economic managers and engineers who was able to manage all aspects of the RET development process and to ensure effective utilization of already trained African analysts and managers (World Bank, 1991). Trained manpower capable of developing and manufacturing renewable energy technologies is a prerequisite for their successful dissemination. Government and ministries in Africa suffer from a shortage of qualified RETs personnel. In Kenya, for example, there is a lack of general expertise in all aspects of RETs in the relevant ministries and NGOs (IT Power, 1987).

Infrastructural Development

From a geological point of view, geothermal energy projects require formation water that is of sufficiently high temperature and a reservoir rock that allows the production of sufficiently large volumes of water. The temperatures required depend on the kind of application. They are, for example somewhat lower for greenhouses than for district heating systems which generally have an inlet temperature of 70◦C. In the Netherlands, water temperatures of 70◦C or higher are found in aquifers deeper than 2000 m and temperatures around 45◦C in aquifers at depths of 1000 to 1200 m (GDC, 2012).

The transmissivity, i.e. the product of thickness and permeability of the aquifer, should be sufficient to permit a production of several thousands of cubic metres per day. It is the main risk factor and often the reason that potential aquifers and locations turn out to be unsuitable. In practice, only thick or very permeable aquifers are prospective. Both in the storage of energy (heat and also cold) at shallow depth and the extraction of heat from greater depth, open or closed systems can be

employed. The water used in an open system circulates from time to time freely through the aquifer. The liquid used to transport heat in a closed system on the contrary always circulates through various kinds of pipes and vessels.

Land Registration

The successful realization of geothermal projects often depends on the level of acceptance by local people. Prevention or minimization of detrimental impacts on the environment, and on land occupiers, as well as the creation of benefits for local communities, is indispensable to obtain social acceptance. Public education and awareness of the probability and severity of detrimental impacts are also important. The necessary prerequisites to secure agreement of local people are: prevention of adverse effects on people's health; minimization of environmental impacts; and creation of direct and ongoing benefits for the resident communities (Rybach, 2010). Geothermal development creates local job opportunities during the exploration, drilling and construction period (typically four years minimum for a greenfield project). It also creates permanent and full-time jobs when the power plant starts to operate (Kagel, 2006) since the geothermal field from which the fluids are extracted must be operated locally.

Empirical Review

Several empirical studies have so far been conducted in relation to the exploitation of geothermal power in both locally and globally. For instance in the global scene, Ingimar (2012) conducted a study to find out the Legal and regulatory framework – barrier or motivation for geothermal development in EU countries. The findings of this study indicated that lack of legislation/regulation affects geothermal development as clarity and consistency are important to geothermal developers, as uncertainties and ambiguities are perceived as risk factors that may delay or hinder development. Further findings indicate that the lack of regulation for geothermal energy exploitation over most of the EU is inhibiting the effective exploitation of the resource (Goodman et al., 2010). Haehnlein, Bayer and Blum (2010) point to a lack of clarity in energy, water and environmental legislation and specific regulation for geothermal energy as the most primary regulatory barriers to geothermal development in Hungary, Ireland, Poland and the United Kingdom. In addition to clarity and consistency of legal and regulatory frameworks across the spectrum of issues pertaining to geothermal development, stability and predictability are of significant importance to developers. This is recognized in the German Renewable Energy Sources Act (EEG), which stipulates feed-in tariffs over a 20 year period. As pointed out by Gassner (2010), this means that developers and investors can reliably calculate yields for the first 20 years of operation. In contrast, renewable electricity tax credits were presented to US federal tax payers through the American Recovery and Reinvestment Act of 2009, but are only available through 2013. While the credits have been extended various times over history, the developer cannot take for granted that such will be the case in the future. Miethling (2010) notes that experts have debated the importance of incentives with such short duration.

Another global study was conducted by Hyungsul and Sadiq (2012) to find out the efficiency of geothermal power plants: a worldwide review. The study indicated that the overall conversion efficiency is affected by many parameters including the power plant design (single or double flash, triple flash, dry steam, binary, or hybrid system), size, gas content, parasitic load, ambient conditions, and others. The study was a worldwide review using published data from 94 geothermal plants (6 dry-

steam, 34 single flash, 18 double flash, 31 binary, 2 hybrid steam-binary and 1 triple flash plants) to find conversion efficiencies based on the reservoir enthalpy. The highest reported conversion efficiency was approximately 21% at the Darajat vapour-dominated system, with a worldwide efficiency average of around 12%. The use of binary plants in low-enthalpy resources has allowed the use of energy from fluid with enthalpy as low as 306 kJ/kg, resulting in a net conversion efficiency of about 1%. A generic geothermal power conversion relation was developed based on the total produced enthalpy. Three additional, more specific, relationships are presented for single flash / dry steam plants, double flash plants, and binary plants. The conversion efficiency of binary plants has the lowest confidence, mainly because of the use of air cooling, which is highly affected by location and seasonal changes in ambient temperature.

In the local scene, Kilonzo (2013) conducted a study on identifying and managing the Market Barriers to Renewable Energy (RE) in Kenya. The study findings indicate that Geothermal Kenya has mainly been operated by government and has seen little progress. With a potential of around 7000MW only hundreds megawatts have been exploited. The government should move from use of parastatals to private sector. The private sector if given a good business environment can exploit and start many projects which can lead to more power been generated from Geothermal (Abeeku, 2008). But in general the study indicate that market barriers which are currently and are likely to continue hindering RE include poor policies and regulatory framework, lack of R&D funding, tax reduction on fossil fuels, high costs of RE installations and projects, long lead times of RE projects, less human resource power and lack or poor awareness on RE potential within the population and FiT. Other market barriers include the government over reliance on hydro power over other RE sources, over reliance on wood fuel by majority of the population and poor involvement of private sector in the energy sector.

METHODOLOGY

This study was carried out through a descriptive survey research method. Orodho (2003) defines a research design as the scheme, outline or plan that is used to generate answers to research problems. The study population consisted of the top, middle and lower level managers at Menengai Geothermal Power Project. Variables were presented using a model which took this form:

$Y=\beta_o+\beta_1 X_1+\beta_2X_2+\beta_3X_3+ \beta_4X_4+\ldots\ldots\beta_nX_n+€$

Where:

Y = dependent variable

βo = constant
β1 = Policies, Legal & Regulatory environment
β2 = Technical Expertise
β3 = Infrastructural development
β4= Capital cost
β5= Land registration
€ = Error term

RESULTS

Capital Costs

The study sought to establish the effect of capital cost on exploitation of geothermal power in Kenya. From the finding majority of the respondents 40% agreed to great extent that capital cost affected exploitation of geothermal power in Kenya, 30% agreed to Moderate extent, 20% to little extent while the minority 10% did not agree on the issue of capital cost. This was indicated in table 1.

Table 1: Capital Costs

	percentage
Great extent	40
Moderate extent	30
little extent	20
Not at all	10
Total	**100**

The objective was to determine the Extent to which Capital Costs affected geothermal energy exploitation. From the findings, respondents agreed to the statements that there was potential for cost reductions in the near future and longer term for both conventional geothermal technology and EGS. The future costs for geothermal electricity were likely to vary widely because future deployment will include an increasing percentage of unconventional development types, such as EGS. Drilling costs reductions due to increasing experience were also based on historical learning curves for directional geothermal drilling. Direct-use project costs have wide range, depending upon specific use, temperature and flow rate required, pressure, associated O&M and labour costs, and output of the geothermal product produced. Geothermal energy exploitation costs are largely due to high costs of drilling equipment, geothermal energy exploitation costs are largely due to high costs of drilling materials

Geothermal energy exploitation costs were largely due to high costs of drilling fuel as indicated by a mean of 3.8, 3.6, 4.6 and 3.7 respectively. These echoed findings by Labys (2006) that higher capital costs can lead to higher inflation, lower corporate profits, higher unemployment and reduced national economic growth. Therefore, it was concluded that capital cost is a key factor in Geothermal energy exploitation.

Technical Expertise

The study sought to find out the extent to which lack of Geothermal Technical Experts influence the exploitation of geothermal power in Kenya. From the findings a majority (40%) agreed to a little extent that lack of Geothermal Technical Experts influenced the exploitation of geothermal power in Kenya, 25% agreed to a moderate, 20% agreed to great extent while 15% did not agree with the statement. According to the results it was an indication that lack of Geothermal Technical Experts does not influence the exploitation of geothermal power in Kenya. This was shown in the figure 2 below.

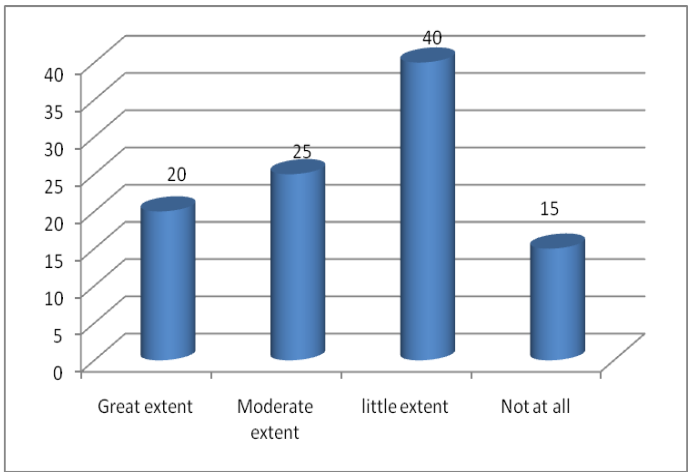

Figure 2: Technical Expertise

The study sought to determine the extent to which the following statements relating to lack of Geothermal Energy Experts and its influence on the exploitation of geothermal power in Kenya. From

the findings, respondents agreed to the statement that The importance of technical know-how in the increased utilization of RETs and geothermal technology has been recognized in the region, but in spite of efforts by governments, there was a continuing shortage of qualified geothermal experts Trained manpower capable of developing and manufacturing renewable energy technologies including geothermal energy is a prerequisite for their successful dissemination and Lack of local and regional expertise in geothermal has technology slowed down geothermal development ion the country.

Legal & Regulatory Framework

The study sought to find the extent to which Legal & Regulatory Framework affected exploitation of geothermal power in Kenya. According to the findings, the study found out that respondents agreed to a Very great extent (56%) Legal & Regulatory Framework affected exploitation of geothermal power in Kenya, 29% agreed to a great extent, 13% agreed to moderate extent while 2% agreed to a little extent that Legal & Regulatory Framework affected exploitation of geothermal power in Kenya as shown in the figure 3 below.

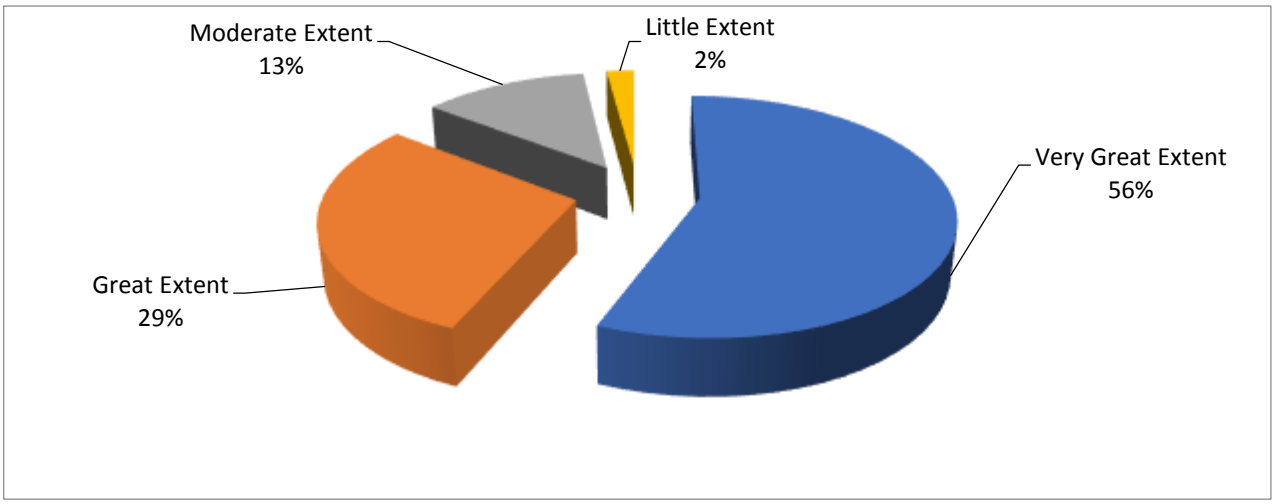

Figure 3: Effects of Legal & Regulatory Framework on exploitation of geothermal power in Kenya

Infrastructural Development

The study sought to find out whether infrastructural Development influenced the exploitation of geothermal power in Kenya. From the findings majority of the respondents 40% agreed to a great extent that infrastructural Development influenced the exploitation of geothermal power in Kenya, 25% agreed to a great extent, 20% moderate extent while the minority 15% doubted if infrastructural Development influence the exploitation of geothermal power in Kenya. The findings were in line with that of Effiong (2009) were the infrastructural problems described as major impediments to LPG distribution and utilization in Nigeria.

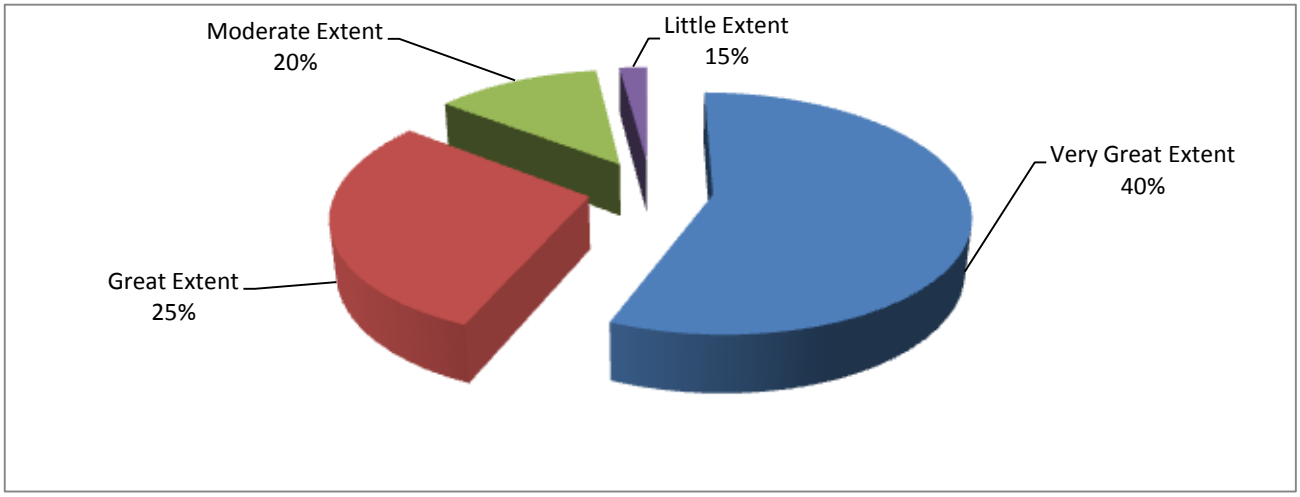

Figure 4: Effects of infrastructural Development influence the exploitation of geothermal power in Kenya

On the extent to which infrastructural Development influence the exploitation of geothermal power in Kenya, majority of the respondents to a great extent the lack of investment in geothermal energy infrastructure had also been described as what is retarding broader access to energy, (particularly to low-income groups in remote rural areas), keeping millions of people at low standards of living by a mean score of 3.0 and a standard deviation of 1.5: that In Kenya, inadequate infrastructural facilities have consistently impeded at the exploitation of Geothermal energy by a mean score of 2.9016 and standard deviation of1.57 Further, Ensuring long-term investment in modern renewable energy infrastructure to satisfy modem energy demand has been described as a key step to enhance sustainable geothermal energy development by a mean score of 1.1967 and a standard deviation of 1.45 and finally A stable economic and energy regulation environment, and rapid, transparent and fair decision-making processes are basic principles that have been put in place that had encouraged investors to support infrastructural development for geothermal energy in Kenya by a mean score of 2.5738 and standard deviation of 1.55.

According to (Schlag *et al.,* 2008) underdeveloped infrastructure had been described as one of the major impediments to the distribution of clean cooking fuel in sub-Sahara Africa. Qualitative analysis of data from the field survey indicates that infrastructure was a major concern and should be looked upon for better service delivery in Kenyan markets.

Land Registration

The study sought to find the extent to which extent does Land Rights influence the exploitation of geothermal power in Kenya. According to the findings, the study found out that respondents agreed to a Very great extent (56%) and land Rights influence the exploitation of geothermal power in Kenya, 29% agreed to a great extent, 13% agreed to moderate extent while 2% agreed to a little extent and land Rights influence the exploitation of geothermal power in Kenya as shown in the figure below.

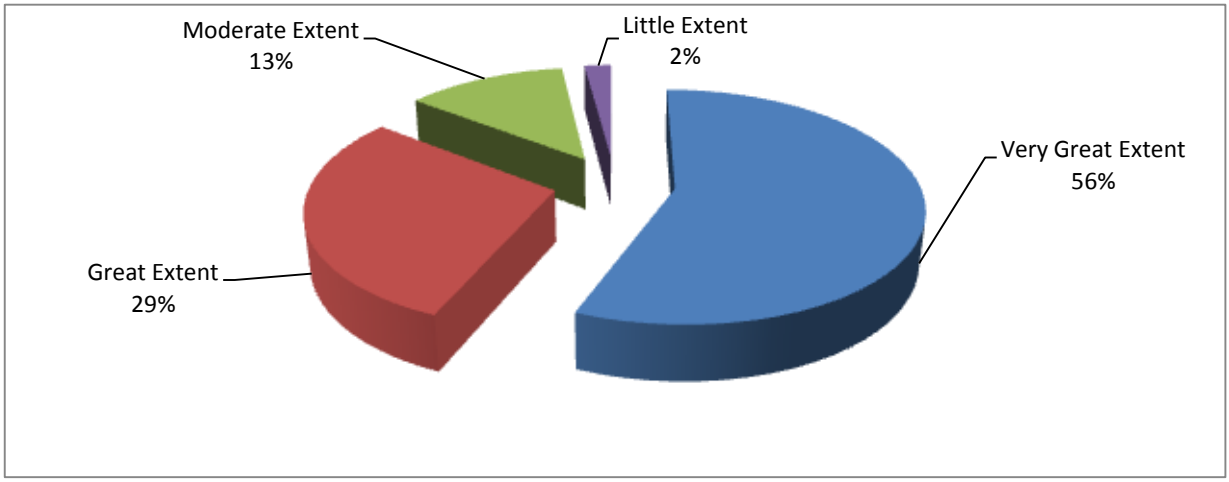

Figure 5: Effects of Safety issues on Land Rights the exploitation of geothermal power in Kenya

On the extent to which Land Access Rights influenced the exploitation of geothermal power in Kenya, The results were presented in mean and standard deviation. The respondents agreed to a very great extent that the successful realization of geothermal projects often depends on the level of acceptance by local people. Prevention or minimization of detrimental impacts on the environment, and on land occupiers, as well as the creation of benefits for local communities, is indispensable to obtain social acceptance by a mean of 4.8667. The study further found out that the respondents agreed to a very great extent that some communities prevent geothermal project from being explored in their land as they consider it as their ancestral land by a mean of 4.5000. Respondents agreed to a moderate extent that Some geothermal companies and government agencies have approached social issues by improving local security, building roads, schools, medical facilities and other community assets, which may be funded by contributions from profits obtained from operating the power plant by a mean of 4.1088 and finally the respondents agreed that Land use issues still seriously constrain the exploitation of geothermal power in Kenya where new projects are often located within or adjacent to national parks or tourist areas, personal lands and government lands by a mean of 3.8043.

CONCLUSIONS AND RECOMMENDATIONS

The study found out that to a very great extent that capital cost affected exploitation of geothermal power in Kenya. Additionally the study found out that Geothermal Energy Technical Experts influence the exploitation of geothermal power in Kenya to a very great extent. The study found out that to a great extent, Legal & Regulatory Framework affected exploitation of geothermal power in Kenya. From the findings, infrastructural Development influences the exploitation of geothermal power in Kenya. The study findings showed that Land Rights influence the exploitation of geothermal power in Kenya to a great extent.

Recommendations

This study established that capital cost positively affects Exploitation of geothermal energy in the Kenyan market to a large extent. The study recommended that cost control should be frequently reviewed so as to improve on the Exploitation of geothermal energy in the Kenyan market. The study also recommended for availability of technical expertise in these exploitation to a great extent. This would not only

help maintain good supply standards but also will help achieve high levels of efficiency and effectiveness.

In addition, to avoid delays in supply and provision of services, the study recommended for improved infrastructure for easy access to drilling sites, evacuation of steam to power plants etc. Further the study recommended for any stable economic and energy regulation environment, a rapid, transparent and fair decision-making processes are basic principles that have to be put in place so as to encouraged investors for development and capacity building

Recommendation for further study

This study looked at five independent variables (Policies, Legal & Regulatory environment capital cost, Technical expertise, Land registration) which according the study contributes to 90.7% of the variations in geothermal exploitation in the Kenyan market. The researcher recommends further research to investigate the other factors that affect geothermal exploitation in the Kenyan market. Equally, further research should be carried out in other sectors to ascertain whether these findings are universal.

REFERENCES

Advisory Group on Energy and Climate Change, (AGECC) (2010). Energy for a sustainable future.

Afrepren (2001). African Energy Data Reference Handbook: AfreprenTrimestrial Report, Volume. IV. Nairobi, Kenya.

Afrepren Data Base, (2000). Energy Data Reference Handbook VI. African Energy Policy Research Network (AFREPREN/FWD), Nairobi, Kenya.

Afrepren, (2002). Afrepren Occasional Paper No. 10: Renewable Energy Technologies in Africa. An Energy Training Course Handbook. Nairobi: AFREPREN/FWD

Baguant, J. (1992). The Case of Mauritius. In: Bahaghavan, M.R., Karekezi, S., (Eds.), Energy Management in Africa. ZED Books and African Energy Policy Research Network (AFREPREN/FWD). London, U.K.

Bazilian, l., Chalifoux, A., James, S.M and Baird, J. (2010). .*Analysis of management methods and application to maintenance of geothermal power plants.*University of Iceland, MSc thesis, UNU-GTP, Reykjavik, report 5, 60 pp.

Bcse. (2003). Geothermal Market Assessment Report, "The Eastern Africa Market Assessment Acceleration" Geothermal Conference Agenda.Business Council for Sustainable Energy (BCSE), Washington, DC.

Borg, D. and Gall, F. (1989). Case Study Research: Design and Methods. London: Sage Publications.

Bronicki, L. (2010). ORMAT'S Experience in implementing Geothermal Projects. The Example of Olkaria III. ORMAT International, Inc.

Central Electricity Board (CEBM). (1996). Annual reports, Ministry of Public Utilities, Curepipe, Mauritius.

Churchill, D. (1991). Research Design: *Qualitative, Quantitative, and Mixed Methods Approaches* pp.130-132.

Deepchand. (2002). Promoting equity in large scale renewable energy development: the case of Mauritius.Energy Policy, 2002.Elselvier Science, Oxford. U.K.

Diab, R.D. (1988). 'The Wind Energy Resource in Southern Africa', Renewable Energy Resources and Technology Development in South Africa, Eberhard, A.A.(ed.), Elan Press, Cape Town, p.167.

Fagbenle, R. (2001). Solar Photovoltaics Technologies in Africa. In: Occassional Paper Number 10. African Energy Data and Terminology Handbook. Nairobi: AFREPREN/FWD

Frankel, P.,Crick, F., Derrick, A. and Bokalders, V. (1993). Windpumps- A Guide for Development Workers, Stockholm Environment Institute (SEI), Stockholm, Sweden,.

Freeman, R. E., Harrison, J. S., and Wicks, A. C. (2007). Managing for Stakeholders:Survival, Reputation and Success: Yale University Press.

Fridleifson, I.B., (2003). Status of geothermal energy amongst the world's energy sources.*Geothermics, 32*, 379-388.

Gall, M. D.; Borg, W.R. and Gall, J. P. (1996). *Education Research: An Introduction.*6th Ed. New York: McGraw-Hill Inc.

Gassner, H., (2010): Feed-in tariffs, support policy and legal framework for geothermal energy in Germany. *Proceedings World Geothermal Congress 2010, Bali, Indonesia*, 4 pp.

GDC, (2013). Geothermal Development Company www.gdc.co.ke Accessed on 17th November, 2013.

GEO. (2008). *Geothermal energy facts.* Geothermal Education Office, website: *www.geothermal.marin.org/pwrheat.html* (accessed November, 2013).

GeoHeat Center. (2008). GeoHeat Center, Klamath Falls, OR, web page: *geoheat.oit.edu.*

Goldemberg, J. and Oswaldo, L. (2010). Energy, Environment and Development, 2nd ed.Cromwell Press Group, London

Goodman, R., Pasquali, R., Dumas, P., Hámor, T., Jaudin, F., Kepinska, B., Reay, D., Rueter, H., Sanner, B., Van Heekeren, V., Bussmann, W., and Jones, G., (2010): GTR-H – geothermal legislation in Europe. *Proceedings World Geothermal Congress 2010, Bali, Indonesi*a, 8 pp.

Haehnlein, S., Bayer, P., and Blum, P., (2010): International legal status of the use of shallow geothermal energy. *Renewable and Sustainable Energy Reviews, Vol. 14*, 2611-2625.

Hopkins, W.E. and S. Hopkins (1997): Strategic planning-financial performance relationships

Hyungsul M., and Sadiq J. Z., (2012). *Efficiency of geothermal power plants: a worldwide review.* New Zealand Geothermal Workshop 2012 Proceedings 19 - 21 November 2012 Auckland, New Zealand.

in banks: A causal examination, *Strategic Management Journal*, Vol. 18:8, p. 635–652.

Ingimar G. H., (2012). *Legal and regulatory framework – barrier or motivation for geothermal development?* Presented at "Short Course on Geothermal Development and Geothermal Wells", organized by UNU-GTP and LaGeo, in Santa Tecla, El Salvador.

IT Power, (1988). Global Wind pump Evaluation Programme- Botswana, IT Power Limited, Rugby.

Kaitano S. R., (2016). *Factors influencing utilization of direct geothermal energy in Kenya. A case of Menengai geothermal project in Nakuru County.* Unpublished Research project for the award of the degree of master of arts in project planning and management of the University of Nairobi.

Kammen D.M. (1991). Solar Cooking For Developing Nations.Harvard University, Cambridge, MA.

Kammen D.M. (1992). The Kenya Solar Box: Appropriate Dissemination in Africa. In: African Technology Forum, Vol.3 No. 1. February/March, 1992. Africa Technology Forum, Cambridge.

Karekezi S. and Kimani J. (2002). 'Status of Power Sector Reform on the Poor', Energy Policy, Vol. 30 Nos. 11-12, Special Issue – Africa: Improving Modern Energy Services for the Poor. Oxford: Elsevier Science Limited

Kiara C. K., (2013). *Determinants that influence the implementation of infrastructure development projects in renewable energy sector in Kenya: a case of Kenya Electricity Generating Company Limited.* Unpublished research project report for the award of the degree Master of Arts in Project Planning and Management of University of Nairobi.

Kilonzo, D. M., (2013). *Identifying and Managing the Market Barriers to Renewable Energy in Kenya .* Unpublished research project in Environmental Engineering in Tampere University of Applied Sciences

Mading P. T., (2013). *Factors influencing community participation in geothermal energy project implementation: a case of Menengai geothermal power project in Kenya.* Unpublished research project report for the award of Master of Arts degree in projects planning and management of the University of Nairobi

Mapako, M. (2000). Renewable and Energy for Rural Development Theme Group: Data and

Miethling, B., (2011): Different but similar: geothermal energy and the role of politics in Germany, Iceland and the United States. *Z Energiewirtsch Vol. 35*, 287-296.

Mutinda P. N., (2009). *An overview of geothermal energy in Kenya.* A report submitted in partial fulfillment of the requirements for the award of the degree of Bachelor of Science in Electrical and Electronics Engineering of the University of Nairobi

Mwandosya, M. J. and Luhanga, M.L.P., Energy Resources Flow and End Use in Tanzania, Dar es Salaam University Press, Tanzania

Mwangi, M. (2008). Financing Geothermal Projects. A paper Presented at Short Courseon Geothermal Project Management and Development, organized by UNU-GTP,KenGen and MEMD-DGSM, at the Imperial Botanical Beach Hotel, Entebbe,Uganda, November 20-22, 2008.

Mwenda G., (2011), Financing of Geothermal Power Projects in Kenya:A Developing Country Model, Geothermal Resources Council, San Diego, California, 39-44, October 2011.

Orodho, A. (2003). Elements of Education and Social Sciences, Research Methods, Gaborone, Botswana, Mozila Publication.

Orodho, A. J. and Kombo, D. K. (2002). *Research Methods.* Nairobi: Kenyatta University, Institute of Open Learning.

Perera, S., &Sugathpala, F. (2000). Boosting the Electricity Sector in West Africa: An Integrative Vision. IAEE Energy Forum 17 (3), 23-29

Petrie M., (2002). A Framework for Public Sector Performance Contracting, *OECD Publications Service*

Phillips, R. R. and Freeman E. (2003). *Stakeholder Theory and Organizational Ethics*.Berrett-Koehler Publishers.ISBN 1576752682.

Smalera, A., Kammen, D.M. (1995). Design and Field Testing of a SavoniusWindpump in Kenya.Princeton University, Princeton.

Smith P. (1990). *The Use of Performance Indicators in the Public Sector*,

Stassen. (1986). Die Regering se rol in die ontwikkeling en implementering Van alternatiewehernubareenergiebronne in Suid-Africa, M.Phil. thesis, Rand Arrikaans University, Johannesburg.

Taylor, F.W., (1998). Dover Publications Inc., 76 pp. *Principles of scientific management*.

Teferra, M. (2000). Energy Sector Reform Theme Group: Data and Statistics Compilation - Ethiopia. African Energy Policy Research Network (AFREPREN/FWD), Nairobi, Kenya.

Therkildsen, O. (2001). Efficiency, Accountability and Implementation, Public Sector Reform in East and Southern Africa, Democracy, Governance and Human Rights Programme Paper, Number 3, UNRISD. Geneva

Trivedi, P. (2000). *How to Evaluate Performance of Government Agency*: A manual for Practitioners. World Bank.

UNDP/PAC, (2009). An Evaluation of Enhanced Geothermal systems Technology.

Vanderhulst, P. LANSER, H., Bergmeyer, P., Albers, R. (1990). Solar Energy: Small Scale Applications in Developing Countries. TOOL, Amsterdam.

Verbeeten, F. H. M. (2007). Performance Management Practices in Public sector Organizations Impact on Performance, *Accounting, Auditing & Accountability Journal,*Vol.. 21 No. 3, pp 427-454.

Verhoest N. (2005). Making staff aware of risks, *Health Manpower Management*, Vol. 21(4), pp. 15–19

Ward, R. F., Ashworth, J,H., Burril, G. (1984). Renewable Energy Technologies in Africa: An Assessment of Field Experience and Future Directions. Bureau for Africa/Agency for International Development. Washington.

WEHAB Working Group. (2002). A Framework for Action on Energy – World Summit on Sustainable Development, Johannesburg 2002