Paper to be presented at *Workshop for Decision Makers on Geothermal Projects and Management,* organized by UNU-GTP and KengGen in Naivasha, Kenya, 14-18 November, 2005

FINANCING GEOTHERMAL PROJECTS IN KENYA

Joseph N. Ng'ang'a
Kenya Electricity Generating Company Ltd
P. O. Box 47936-00100, Nairobi
KENYA

ABSTRACT

Resource prioritization in geothermal energy development is a core function of policy makers in any country. In Kenya, the known geothermal prospects occur within the Great Rift Valley where widespread volcanic activity and geothermal manifestations signify existence of viable geothermal resources, which can be utilized for both electricity generation and direct use. Geothermal resources in the rift are estimated to be able to support generation of over 2000 MWe. The Country's Least Cost Generation Expansion Programme has identified geothermal to be among the least-cost sources of indigenous energy in Kenya. Based on this programme, the National Power Development Plan requires an additional 512 MWe of geothermal power to be installed by the year 2020. This requires an estimated funding in the region of US$174 million per field for a 70 MWe power plant. This is a significant figure for a developing country such as Kenya. As would be expected therefore, funding remains the biggest hurdle to developing this resource in the country. To meet the indicated target in the next 15 years or so, it is necessary that a reliable cash stream be established to meet the anticipated requirements. The initial high-risk exploration activities leading to pre-feasibility work should remain the responsibility of public institutions (Government) as part of their inventory of the country's resources. Power plant construction can be shared between the public sector and/or independent power producers. The institutional framework, legislation and legal constraints also need to be addressed to reduce contract or policy uncertainties and expedite licensing so as to attract private developers in the industry.

1. BACKGROUND

Reforms in the power sector in Kenya have opened up the industry to private sector participation and to the consequent competition. This has necessitated a review of the manner in which financing of geothermal projects is being undertaken in the country, in order to enhance operational efficiency and cost-effectiveness.

Geothermal projects are capital intensive. Like other projects of a similar nature, their feasibility in terms of technology, economic, financial, market and management perspective need to be verified prior to their execution.This is especially critical in a developing economy where the ranking of priorities may limit resources even in areas that are crucial in the take-off of the economy, such as the energy sector among the key tools that determine the feasibility of projects, especially those that involve multiple local and international stakeholders is, inter alia, the economic and financial analysis. Suffice to mention it, the effect of a chosen option on global warming and the overall environmental friendliness of the resource is now a major issue to be addressed at the feasibility stage.

Economic analysis
This evaluates the priority of the project from the country's point of view. It is an evaluation of whether the country is using its resources efficiently. It seeks to test whether the project is in a sector

that has a high priority with respect to allocation of resources and whether it will generate enough economic benefits to justify the use of scarce resources. It treats taxes and other government levies as transfers within the country and therefore ignores them since they do not change the overall wealth of the economy. Where the domestic inputs and outputs do not reflect the opportunity cost to the economy, for instance in the case of subsidies, 'shadow prices' are used in the economic analysis. For traded goods, shadow prices are international (world) prices at the border of the country i.e. prices before imposition of duty and other local taxes.

Financial analysis
This is an evaluation of the project from the sponsor's point of view. This ordinarily is a tool to confirm if, or whether, the project will generate enough future income to meet the initial investment and the expectations of various stakeholders, such as those who contribute equity to the project or provide loans. Normally, alternative avenues are available to investors and there is hardly any prudent business person who would want to put their money in an investment where the returns are lower than what they would get in other investments, for instance, in the equity market or government securities.

2. STATUS OF GEOTHERMAL DEVELOPMENT IN KENYA

Geothermal projects typically progress from surface reconnaissance work, exploration activities and subsequent developments that culminate in the construction of a power plant or other direct application installation.

In Kenya, geothermal prospects occur within the Rift (Figure 1) where wide spread volcanic activity and geothermal manifestations signify the existence of geothermal resources. Exploration for geothermal energy started in the early fifties when two wells were drilled in Olkaria. In 1970, The United Nations Development Programme (UNDP) and the Kenya Power and Lighting Company (KPLC) carried out an extensive exploration programme in the Kenya Rift. This survey ranked Olkaria as the best candidate for exploratory drilling. By the mid-seventies, six deep wells had been drilled and the first 15 MWe generating unit was commissioned in 1981.

Kenya Electricity Generating Company Ltd (KenGen), which is a wholly owned Government Institution, is charged with the exploration and development of geothermal resources in the country. Together with UNDP, British Geological Survey (BGS), Geotermica Italiana Srl and other organizations, they have continued to support, and to explore, for geothermal energy in the Kenya Rift. Geotermica Italiana Srl in 1987 carried out a reconnaissance survey in the area between Menengai and Lake Bogoria. The BGS in 1992 carried out geothermal reconnaissance studies of geothermal prospects north of Lake Baringo and from their studies identified both high enthalpy geothermal systems associated with young volcanic centres and high geothermometry temperatures and low enthalpy systems associated with extremely weak surface manifestations and low geothermometer temperatures.

The Least Cost Generation Expansion Plan (KPLC, 2001) identified geothermal energy to be the least-cost baseload source of power for Kenya in the current planning horizon. This requires that 512 MWe (8 x 64 MWe) of geothermal power be installed by the year 2020. In view of this, the Ministry of Energy has drawn up a Geothermal Resources Assessment Programme to achieve this target. KenGen has been contracted by the Ministry to do this work on its behalf. More than 13 geothermal prospects have been identified in the Kenya Rift (Figure 1), but so far drilling has been carried out in Olkaria and Eburru only. KenGen has so far carried out detailed surface work at Olkaria, Eburru, Suswa, Longonot, Menengai, Lake Baringo and Arus and Lake Bogoria prospects. The geothermal resource in the Kenya rift is vast and is estimated to be over 2000 MWe (Omenda, 2001). The current status of the geothermal prospects is shown in Table 1 below.

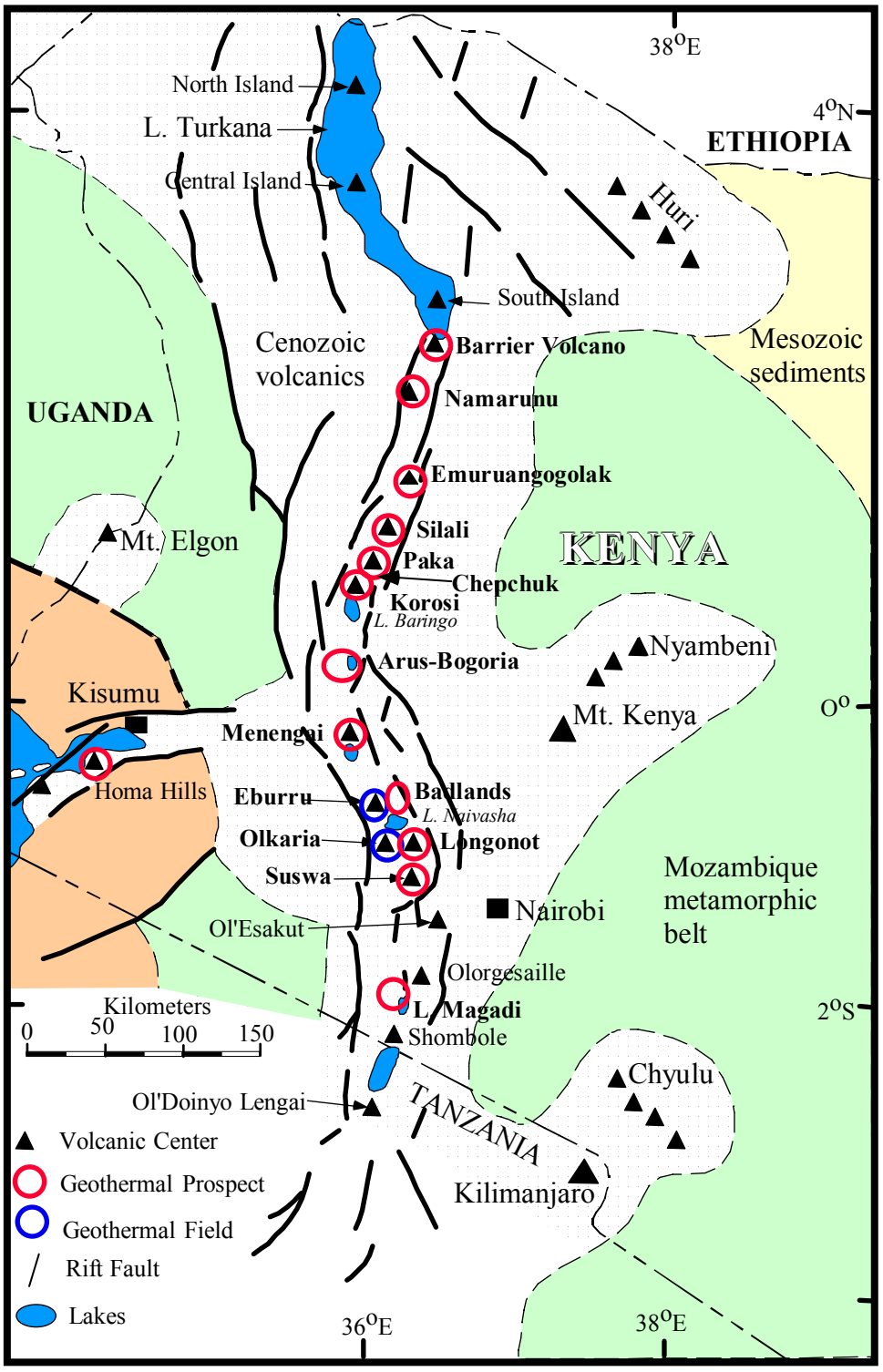

FIGURE 1: Simplified geological map of western and central Kenya showing the locations of geothermal fields and prospects.

The proven resources at Olkaria and Eburru are about 173 MWe and 20 MWe of electricity, respectively. KenGen so far owns 2 power stations (Olkaria I and Olkaria II) with capacities of 45 MWe and 70 MWe, respectively, and plans also to construct a small power plant at Eburru later in the year. Olkaria II will have an additional 35 MWe unit utilizing excess steam from Olkaria I and Olkaria II fields. The Government of Kenya has also granted OrPower 4 Inc. (an Independent Power Producer

(IPP)) a license to develop a 48 MWe power station in Olkaria West (Olkaria III). The IPP has already installed and commissioned a 12 MWe binary plant. Olkaria Domes, which is a candidate for Olkaria IV, will be appraised by drilling later in the year. At the same time, Oserian Flowers Ltd, a company growing horticultural flowers for export has commissioned a 1.28 MWe power plant that is used to supply electricity and to heat greenhouses.

The substantive utilization of geothermal energy in Kenya currently is mainly for electric power generation. Apart from Oserian, direct uses have been operational in other parts of the country. For instance, in Eburru, farmers have for decades used geothermal heat to dry pyrethrum flowers and also to condense steam for domestic uses. Similarly, a tourist hotel at Lake Bogoria is utilizing hot spring water to heat a swimming pool.

TABLE 1: Exploration status of geothermal prospects

Prospect	Inception Report	Surface Studies	Wells Sited	Wells Drilled
Longonot	Done	Done	Done	Not Done
Suswa	Done	Done	Done	Not Done
Menengai	Done	Done	Done	Not Done
Arus and L. Bogoria	Done	Done	Done	Not Done
Korosi and Chepchuk	Done	Not Done	Not Done	Not Done
Paka	Done	Not Done	Not Done	Not Done
Silali	Done	Not Done	Not Done	Not Done
Emuruangogolak	Not Done	Not Done	Not Done	Not Done
Namarunu	Not Done	Not Done	Not Done	Not Done
Barrier Volcano	Not Done	Not Done	Not Done	Not Done

3. GEOTHERMAL DEVELOPMENT COSTS

Geothermal energy emanates from the earth's interior. To access it entails tapping into the ground, usually by drilling wells. Like other natural resources from the ground, there is a degree of risk associated with prospecting for this resource. The risk is, however, minimized by a carefully crafted exploration and development programme.

The first step in geothermal development is to conduct surveys of moderate cost that will provide prospectors with a rapid assessment of large areas and permit to select, within this large area, the most promising parts. Thereafter, more detailed, and of course more expensive, investigations can be carried out in these areas to identify one or more favourable sites for deep exploratory drilling. Exploratory drilling and well testing represent the next stage of the project; the cost of this stage is higher than that of the preceding surveys since drilling is capital-intensive. Due to the nature of rocks, and the high probability of encountering lost-circulation zones, the cost of drilling can be quite high. The project phase then shifts to field development and production, which, in addition to more drilling, entails reservoir engineering studies and the construction of surface plants and equipment. These activities are also capital-intensive.

In order to appreciate the funding levels at the various stages of development, a summary of what is involved and their estimated costs is given hereunder:

3.1 Resource Exploration

In many countries, government institutions, and to a lesser degree, private investors, shoulder the burden of exploration for geothermal resources. In some countries, the private sector bids for the resource areas based on data acquired during surface studies. However, in Kenya, the Government is

responsible for carrying out surface reconnaissance work and exploration drilling. The output of a successful surface studies programme is the siting of exploration wells. Exploration drilling is the key to positively identifying areas of possible geothermal exploitation. This stage involves drilling of at least 3 deep (2,000-2,500 m) exploration wells at a cost of about US$ 7.5 million inclusive of the infrastructure and land compensation. Testing of the wells would cost another US$ 0.25 million, bringing the cost of undertaking the resource exploration work to about US$ 8 million. KenGen is currently carrying out these activities on behalf of the Government.

3.2 Resource Assessment

The resource assessment stage involves appraising the proven field to determine the extent of the reservoir. This requires drilling of at least 6 - 9 deep wells (2,000 - 2,500 m) which account for about 30-50% of the steam required for a 70 MWe power plant. The six appraisal wells cost about US$ 15 million and testing them would cost another US$ 0.25 million. Simulation, pre-feasibility and Environmental Impact Assessment studies will be carried out after the wells have been drilled and this will cost another additional US$ 0.25 million. This activity phase is also the responsibility of the Kenya Government. The total funding requirement is in the region of US$ 15.5 million.

3.3 Power Plant Development

Ordinarily, the data provided by appraisal wells is capable of verifying all the hypotheses about the resource, including any postulated natural-state models. It is also used in confirming that the reservoir is productive and contains enough fluids, of appropriate characteristics, for the purpose for which it is intended. This stage involves drilling of about 18 production wells at a cost of about US$ 45.5 million inclusive of testing, design, and construction of the power plant, steam gathering systems and inter-connection of transmission lines which would cost a total of about US$ 105 million. The Power Plant Construction work involves the connection of wells to the power plant, installation of the brine re-injection systems, building the power station and installing all the required auxiliary facilities. This stage of development is also capital intensive and requires substantial amount of funding in the region of about US$ 150.5 million.

4. HURDLES TO FINANCING GEOTHERMAL PROJECTS

It is generally a rule of thumb presently in the developing world, and even in the first world, for policy makers to focus on those energy sources that are environmentally friendly, are indigenous to an area, improve the standard of life in the rural areas and attract private sector funding. Geothermal energy is a prime candidate for compatibility with these policy guidelines. Its Achilles hill, nevertheless, is the large capital outlay that is needed to bring it online.

4.1 Commercial financing and country risk barriers

Commercial financing barriers arise as a result of the high up-front costs of geothermal energy projects, especially before a resource is confirmed. Very few institutions can lend money when the future income from the development is actually uncertain. This increases the project's financial risk profile.

Country risk barriers are particularly prevalent in geothermal and renewable energy projects since these projects are mostly located in developing countries. These are at times viewed with uncertainty due to perceived, and at times real, instabilities within the regimes and the body politic. As a result countries, which can benefit the most from renewable energy projects, are often the least attractive to financing institutions.

4.2 Legislative Framework

Geothermal plants can co-exist with other land users as has been demonstrated in the Olkaria Geothermal field where the project is in a national park. This is a demonstration of the need to have a supportive legal framework that can allow multiple exploitation of the country's resources without undue conflict. It should also be possible for private developers to see that the playing field is level, insofar as the local competition is concerned, especially where they have to produce from the same field. In addition, with an investment horizon of 20-30 years, investors are keen to see predictability in the way the legislative regime changes with time.

4.3 Concessionary Funding

Bilateral and Multilateral agencies, as is demonstrated hereinafter, are able to offer loans or credits to developing countries at concessionary rates with attractive repayment terms, to foster development. However, like other big institutions, they tend to have time-consuming and structured procedural requirements that at times go beyond the specific project requirements, to sectoral and country issues. This is exemplified by the financing of the Olkaria II Geothermal Power Project, where the World Bank, the European Investment Bank (EIB) and the Kreditanstalt Für Wiederaufbau (KfW) of Germany were involved.

The International Development Association (IDA), the soft-lending affiliate of the World Bank, was the lead financier of this project and provided a sum of SDR 86.6 million (equivalent to about US $ 125 million) towards the construction of the power plant, amongst other sectoral needs. This was contingent upon KenGen being able to raise from its internal resources between 20-25% of its capital expenditure requirements annually. There was also a requirement to ensure that the debt service ratio was at least 1.5 times the estimated debt service requirements of KenGen. The Credit was to finance 100% of foreign expenditures for consultancy, procurement and training. All key procurements milestones required the concurrence of the financier, for instance in awarding contracts and the selection of consultants. The repayment terms were quite concessionary, with the interest being 1% of the principal amount during the first 10 years and 2% over the remaining period of 20 years. There was a caveat, however, that in the event of the country's per capita gross national product (GNP) exceeding the level set by the Bank for eligibility of its loans in three consecutive years, the Terms may be modified to provide for higher rate of payment for each installment. It needs to be noted, however, that these terms are applicable to the government as the borrower. Thereafter, it on-lends the funds to the executing agency, such as KenGen, which in this instance was to pay back the loan to the government at an interest rate of 7.7%. As part of its deal with the development partners, KenGen was required to maintain competent staff in adequate numbers and to conduct its operations and business affairs in a sound and prudent manner.

The European Investment Bank, on the other hand, provided some 41 million Euros (about US $ 37 million) towards the financing of the project. This was conditional on IDA, KfW and KenGen providing their own contributions. A key environmental requirement by this financier was to ensure free movement of wildlife within the Olkaria area, Hell's Gate and Longonot National Parks. There was also a requirement that all mitigating measures that will be necessary in minimizing the impact of the project on the environment are addressed. In addition, all procurement was to be undertaken through international competitive bidding and open to nationals of all countries. There was also an understanding that in the event of a project overrun, any additional funds that may be necessary will be provided by the borrower and/or the executing agency, not the financier. The loan to the government was at a rate of interest of 3% per annum repayable in 30 semi-annual installments over a term of 15 years with a grace period of 5 years. The funds are thereafter on-lent to KenGen at EIB's interest rate applicable at the respective time, plus a margin of 1% to be retained by the government for servicing the facility. Another condition that this financier was keen on is to ensure that all the project installations are insured and the borrower retains the title to, and possession of, assets acquired through the loan.

The third financier in the project, KfW, provided a loan of DM 25 million (equivalent to US $ 11.7 million) to fund the steamfield development, preferably the foreign component. Like the other two financiers, it required all procurement to be through international competitive bidding and contractual provisions to be in accordance with the 'Guidelines of KfW for procurement in the Fields of Financial Cooperation between the Federal Republic of Germany and Developing Countries'. The executing agency was also to assign a consultant to assist in the supervision of the project implementation and to establish a separate Project Implementation Unit to coordinate all project activities. And to ensure financial stability of KenGen, EIB required the bulk supply tariff of the Company reflected in the Power Purchase Agreement (PPA) between KenGen and the power distributing entity, Kenya Power and Lighting Company Ltd. (KPLC). It also required a schedule of tariff adjustments to achieve the full coverage of the long-run marginal cost (LRMC) of the sector and to facilitate a self-financing capability of 25% for KenGen. The loan proceeds were to be repaid over a 30 year period with a grace period of 10 years for the borrower. Interest on the loan was 0.75% per annum but KenGen was to repay the borrower (Government of Kenya) interest in Kenya currency equivalent at the rate of 7.7% per annum on the principal loan. The payments, on the part of KenGen, were also to start after a grace period of 5 years.

Bids for construction of the project were called in mid-1999 after completion of the financial closure in 1998. The various contract packages were awarded between February and June 2000. Civil construction work started in October 2000. The first of two turbines with a total output of 70 MW was commissioned in September 2003 and the second one followed two months later in November 2003. The final project cost was US $ 185 million. This was inclusive of a project escalation of 4.1%, variations of 4.0% and claims of 20%. The latter figure was substantial due to financing problems that affected payments to contractors during the early phase of implementation of the project. And to put the final cost into perspective, it should be borne in mind that this included the following infrastructural items:

- 3.56 km of a 132 kV single circuit to Olkaria I
- 71 Km of a 220 kV double circuit to Nairobi
- 46 km of a 220 kV double circuit to Dandora
- a 220/132 kV switchyard at Olkaria II
- 220/66 kV substation in Nairobi North
- extensions to the 220/132 kV substation in Dandora
- construction of 34 houses and medical clinic
- water pumping and treatment plant

5. OPTIONS FOR FUNDING GEOTHERMAL DEVELOPMENT IN KENYA

5.1 Geothermal Resource Exploration and Assessment

As already mentioned, the major limitation to geothermal development in Kenya is availability of funds. The saving grace, however, is that the initial high-risk stages of geothermal resource exploration and reservoir assessment will most probably remain the responsibility of the Government. IPPs and other commercial lenders are usually not willing to invest at this stage because of apprehension on the high-risk capital requirements and, at times, real or perceived country risk. To interest these institutions, the Kenya Government may have to fund the exploration activities and prove the resource to between 50 -100% of the anticipated steam requirement. These two stages of exploration work are estimated to cost about US$ 23.5 million. Various options for acquiring these

funds are discussed hereinafter. Nevertheless, they are not mutually exclusive; they can be used in a combination depending on the funding requirements.

Research and Development fund: The Government of Kenya can make a provision for a research and development budget at the national level, a portion of which can be used to verify the stock of natural resources which can be exploited both in the short-, medium- and long-term depending on priorities.

KenGen Profits and/or Taxes: A portion of the KenGen profits and or taxes due to the Government can be set aside for the development of geothermal resources.

Differential in interest on on-lent funds: The Ministry of Finance can forfeit the differential interest it receives from KenGen and other various institutions when it on-lends funds from development partners. This can be directed to research and development activities on energy and other priority sectors.

Incentives and risk reduction programmes: Tax incentives can be considered to reduce the initial capital outlay, for instance in duties and VAT, corporation tax and reduced royalties.

Geothermal Energy Levy: The Government should review the merit of introducing a geothermal energy development levy to provide a guaranteed income stream for the proposed Geothermal Development Company, which will oversee development of geothermal resources in the country.

Public Private Partnerships: KenGen and IPPs can partner to provide the requisite up-front funds if they are given the appropriate incentives coupled with exclusive producer rights.

Grants: Government should allocate more resources in seeking, and facilitating, grants from research-oriented programmes, such as from universities, towards advancement, in whatever form, of geothermal development activities.

Carbon Credit Mechanism: Funds earned from carbon credits for reducing the amount of CO_2 emitted into the atmosphere by using clean sources of energy can be used to develop geothermal resources.

Risk Guarantee Fund: Establishment of a risk fund that could be used to accelerate geothermal development in Kenya is long overdue. The Global Environmental Fund (GEF) is currently working on the establishment of such an initiative within the East African Rift system.

5.2 Power Plant Construction

Power plant construction involves connection of producing wells to the power plant, installation of the brine reinjection systems, building the power station and installation of the required auxiliary facilities. At this juncture, since the initial high risks involved in the development have already been borne by various parties and a bankable proposal is already available, it is usually easy to sell the project to financiers and other providers of capital. The funds required at this stage are in the region of US$ 150.5 million. The following financing options can be applied, again without being mutually exclusive:

Limited or International Competitive Bidding to private and public institutions: The Ministry of Energy can offer the power plant construction on competitive basis to IPPs and KenGen.

Strategic Alliances: This is similar to the public private partnership but in this case KenGen can do all the field development work and thereafter sell steam to IPPs, who will source for the requisite

capital to put up the power plants. A special-purpose company can be registered where the various parties can be shareholders depending on their contribution to the project.

Carbon credit: Geothermal energy in many countries displaces the need for fossil fuels in the generation mix. This qualifies for carbon credits as explained earlier.

Tax incentives: Like in the geothermal resource and reservoir phase, tax incentives such as tax holidays can be enacted to provide tax savings, giving concessions and waiving duties for geothermal power plant construction. This would reduce the initial capital outlay and make geothermal much more attractive to investors.

Sale of Bonds: Government should consider the sale of a special long-term bond, with an attractive return, which can be floated in the stock market to raise funds for geothermal power plant construction.

Early Generation: After the appraisal stage of a field, about 10 wells would have been drilled and tested. Installation of early generating units can provide a cash stream for further production drilling and power plant construction.

6. CONCLUSIONS AND RECOMMENDATIONS

Geothermal energy is an attractive alternative to fossil fuels, which have to be imported into the country. And because it is not affected by the vagaries of weather, it could even have an edge over hydro generation in some cases. It will continue to be one of the primary, renewable, sources of power generation and direct utilization in Kenya. To be able to sustain and improve on this, a substantial amount of funding will be necessary. The initial high-risk investment stages of geothermal exploration and reservoir assessment should continue to be borne by public institutions (Government). Government should therefore set up a geothermal company, which will be responsible for these stages of the development. The initial risk having been minimised, the later stages of geothermal resource the development, which include steam pipeline and power plant construction, can be shared between public institutions, IPPs and providers of finance, whether equity or loans.

Private power producers approach geothermal projects as any other business venture, in which the return from investment should be commensurate with the attendant risks, with an eye on the bottom line, pay back time, and the internal rate of return of the project. The main incentives, which attract private operators, are appropriate financial packages and geothermal resources, which perform to productivity expectations, or better. This can be achieved by deliberate policies that focus on the promotion of the environmental benefits of geothermal energy and as indigenous renewable resource. An enabling legal framework is also necessary to ensure equitable treatment of all players in the industry.

ACKNOWLEDGEMENTS

The author would like to thank the scientists and engineers at Olkaria for reviewing this manuscript and suggesting several inputs, which greatly improved the paper.

REFERENCES

Bloomquist, R. G., 2003: *United States geothermal policy - Provision of access and encouraging project development.* IGC 2003 Short Course.

Dunkley, P. N., Smith, M., Allen, D. J. and Darling, W. G., 1993: *The geothermal activity and geology of the northern sector of the Kenya Rift Valley*. British Geological Survey Research Report SC/93/1.

European Investment Bank.,1999: *KPLC-Olkaria Geothermal Project Power II Project*: Finance Contract between the Republic of Kenya and European Investment Bank.

Finnerty, J.D., 1996: *Project Financing: Asset-Based Financial Engineering*, John Wiley & Sons, Inc. New York

Geotermica Italiana Srl., 1987: *Geothermal reconnaissance survey in the Menengai- Bogoria area of the Kenya Rift Valley*. UN (DTCD)/ GOK

International Development Association, 1998: *Development Agreement between Republic of Kenya and International Development Association:* Energy Sector Reform and Power Development Project – Credit 2966 KE.

Kenya Electricity Generating Company Ltd., 2004: *Olkaria II Geothermal Power Project Completion Report.*

Kenya Power and Lighting Company Ltd., 2001: *The Least Cost Power Development Plan: Year 2001 update*. KPLC Internal Report.

KfW, 1999: *Loan and Project Agreement between Kreditanstalt Für Wiederaufbau, Frankfurt am Main and the Republic of Kenya and the Kenya Electricity Generating Company Ltd*. For Olkaria Geothermal Power Plant.

Mwangi, M. N., 2002: Geothermal Resource Assessment Funding. *Proceedings of the 2nd KenGen Technical Seminar.*

Omenda, P.A., 2000 (editor): *Ranking of the Geothermal Prospects in the Kenya Rift Valley*. With contributions from: J. Lagat; J. Mungania; N. Mariita; S. Onacha; S. Simiyu; K. Opondo; P. B. Kubo; P. Ouma, G. Wetangula; P. Khollikoh; and P. A. Omenda. Kenya Electricity Generating Company, Internal Report.

World Bank: *Guidelines for Calculating Financial and Economic Rates of Return for DFC Projects.*