Presented at Short Course on 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.

UNITED NATIONS UNIVERSITY
GEOTHERMAL TRAINING PROGRAMME

KenGen DGSM

THE AFRICAN RIFT GEOTHERMAL FACILITY (ARGeo)

Martin N. Mwangi
GeoSteam Services Ltd
P.O. Box 4 - 20117 Naivasha
KENYA
mmwangi@safaricom.com

ABSTRACT

The African Rift system is predicted to have high potential for geothermal energy. However, only Kenya and Ethiopia have installed about six big and small power stations with a total capacity of 139MW. Although geothermal energy is an economically viable energy option in Eastern Africa, the need for detailed exploration and the high cost and risk of exploratory drilling, compounded by institutional and regulatory barriers, have prevented the exploitation of this indigenous and environmentally friendly energy source in the region. In order to overcome the financial, investment and technical risks and barriers, and to replicate the success of geothermal development in Kenya and Ethiopia, throughout the region, an African Rift Geothermal Facility (ARGeo) was established. ARGeo project is funded by the Global Environment Facility (GEF) and was initiated by six countries- Ethiopia, Eritrea, Djibouti, Kenya, Uganda, and Tanzania - and implemented by the United Nations Environment Programme (UNEP) and the World Bank. The project will be executed in partnership with UNU-GTP, ICEIDA, the German Geological Agency (BGR) and others. KfW of Germany was initially very keen in funding the project but pulled out due to some misunderstanding. Currently about USD 18.6 million is available from GEF to fund the various components. ICEIDA and BGR have provided some extra funds to be used in training and exploration activities and conferences. The project has a comprehensive program of financial, policy and technical instruments for the promotion of geothermal energy that will directly support the development of viable geothermal energy resources in the African Rift. The project is also designed to actively reduce barriers and to stimulate and facilitate investment through public and private sector partnership through a drilling risk mitigation fund, a technical assistance and institutional strengthening program. A pipeline of eligible projects has been developed, and an initial first project selected for immediate support. The project has yet to be approved by the GEF CEO and the World Bank Board. The project is also currently underfunded.

1. INTRODUCTION

The African Rift Valley system extends from the Red Sea to Mozambique through Yemen, Eritrea, Djibouti, Ethiopia, Kenya, Tanzania, Uganda, Rwanda, Burundi, the Democratic republic of Congo, Zambia, Malawi, Mozambique, and Madagascar. Geothermal power potential in Africa's Rift Valley is estimated to exceed 7,000MW.

Despite the high geothermal potential of the African Rift, only Kenya and Ethiopia have installed some capacity of some 139 MW. However, compelled by rising cost of fossil fuels (reaching 147$ per barrel in 2008), drought and siltation affecting hydro dams in Eastern Africa, and current and projected electricity needs far exceeding installed generation capacity, countries in Eastern Africa have been very keen to develop alternative indigenous energy resources. Geothermal energy is suitable indigenous renewable energy resource that provides base-load, reliable, affordable and environmentally friendly power.

The reasons for the largely unexploited geothermal resources in the African Rift countries compared to some other developing countries are due to the lack of supporting policies, regulatory frameworks, technical capacity, and resource information on the one hand, and the low level of funding of exploration activities and the high-cost and high-risk exploration and appraisal drilling on the other hand. Except for Kenya, awareness of high-level policy-makers that geothermal energy is a least-cost option in Eastern Africa is low, and generally there has been a lack of promotion of the enormous geothermal potential in the region.

Although some exploration activities and drilling started way back in the seventies, only a few prospects have been developed. The type of barriers encountered are: (i) financial due to the high up-front investment cost, (ii) legal and regulatory barriers as a result of inadequate legal and regulatory frameworks to support geothermal energy development and stimulate private-sector investment, (iii) institutional barriers in the form of institutional weaknesses to promote geothermal development, and to identify, prepare, and implement feasible geothermal projects and (iv) technical barriers, both at the level of human resources, equipment and technological know-how, and (v) market barriers rooted in insufficient information on competitiveness of proposed geothermal development compared with traditional energy sources and in the lack of geothermal development targets in national or regional energy planning. Moreover, the difficult access to foreign financial sources, the scarcity of funds in the countries, and in some cases the lack of creditworthiness, collateral, and equity among interested project promoters have further hampered or slowed development of geothermal prospects in the Rift Valley.

Encouraged by Kenya's plans to further develop its geothermal resources, and by the growing interest to do so in other countries in the Rift Valley, the United Nations Environment Programme (UNEP), the Business Council for Sustainable Energy (BCSE), the US Trade and Development Agency and a number of other US agencies and international organizations, organized an Eastern Africa Market Acceleration Conference in April 2003, in Nairobi, Kenya. The conference brought together high-level representatives from Energy Ministries, utilities and geothermal agencies from Kenya, Tanzania, Zambia, Djibouti, Uganda, Ethiopia, Eritrea, Rwanda and Malawi as well as leading representatives from the industry, bilateral and multilateral organizations and private financing agencies, to explore commercial opportunities for geothermal development in the region and options for overcoming financial, regulatory and institutional barriers.

It was agreed, among other things, that the Eastern African Geothermal Development Initiative undertake to develop about 1000 MW of geothermal power by the year 2025 and a call was made for technical assistance and financial instruments to achieve this target. It was also agreed that the initiative, which was to be promoted through NEPAD, should include a risk mitigation fund against drilling risk, technical assistance, transaction advice services, policy support, and linkage to preferable finance.

The resolution formed the basis for the establishment by six countries in Eastern Africa of the African Rift Geothermal Facility (ARGeo) in May 2003 by GEF. The ARGeo project received Global Environment Facility development funds to be implemented by the United Nations Environment Programme (UNEP) and initially by the German Development Bank (KfW) but later the World Bank. According to the original plan, the project was to start in 2005 and take a period of 10 years. However

there have been huge delays and very limited funds. Currently the funds available from GEF are about USD 18.6 million. The project will be executed in partnership with the United Nations University Geothermal Training Programme (UNU-GT), ICEIDA, the German Geological Agency (BGR) and others. The project proposes to establish a comprehensive program of financial, policy and technical instruments for the promotion of geothermal energy that will directly support the development of viable geothermal energy resources in the African Rift. The project is designed to actively reduce barriers and to stimulate and facilitate investment through public and private sector partnership through a drilling risk guarantee fund and a technical assistance program and institutional strengthening. A pipeline of eligible projects was then developed for each country and the first one selected for approval.

2. THE ESTABLISHMENT OF THE AFRICAN RIFT GEOTHERMAL FACILITY (ARGeo)

Whereas the overall goal of the African Rift Geothermal Development Facility is to reduce greenhouse gas emissions by promoting the adoption of geothermal energy as a clean, renewable and economically viable energy source for the African Rift region, the immediate objective is to facilitate broadened scale geothermal energy installation along the African Rift by removing exploratory and financial investment risks. To achieve the objective, the ARGeo project was then established by UNEP in consultation with the six recipient African countries, multilateral organizations and technical cooperation and financial agencies.

ARGeo is founded on the thinking that: only an integrated and systematic approach to overcome regulatory, technical and institutional barriers and to assist countries to access finance and attract private sector and/or public-private partnerships will lead to the development and acceleration of the geothermal resources for electricity generation; countries have to take on the bulk of the risk of surface exploration and drilling and will need technical and financial assistance to do so; without private sector investment, geothermal development will not take off, the systematic assessment of geothermal prospects in order to prioritize ARGeo funding; the demonstrated commitment by the countries to develop geothermal resources for power generation.

To achieve the objectives outlined above, there are two main instruments required, namely the risk mitigation fund and the regional geothermal network and by considering mechanisms for a sustained impact through the facility over possibly 25 years for the more significant geothermal resources of the region to be tapped. In addition to the first round of several priority projects (hopefully one for each recipient ARGeo country), it is expected that replication efforts will engage countries in the region in a sustained and systematic effort to develop geothermal energy. This will be fostered and through capacity building activities, support for surface studies, socio-economic analysis, and policy support, including in countries that are at a very early stage of geothermal exploration. While the facility is geared towards overcoming barriers in the whole region, accelerated geothermal development in pioneer countries is considered important by the project proponents for replication and broadened acceptance in the rest of the region. The technical capacity and experience of pioneer countries will serve as an example upon which to improve and replicate the process of geothermal energy development in the region. Taking advantage from the Olkaria (Kenya) and Aluto Langano (Ethiopia) experiences, lessons learned are incorporated in the project design, whereas a regional approach will ensure cooperation and a more effective use of available resources in the region. Participation in ARGeo of bilateral and multilateral agencies is encouraged and facilitated at the design and implementation stages, with the view to create a broad international partnership for the facility. The partnership will make it possible to build on current and planned activities, to bring to bear the expertise and experience of these agencies, and to complement the funding from GEF to achieve the project's objectives.

Acting as implementing and executing agencies of the project, the UNEP and the World Bank have experience in and have developed appropriate technical and financial tools for an adaptable and

sustainable geothermal development facility. The World Bank has experience in co-financing individual geothermal plants with the KfW, KenGen, and the European Investment Bank (for Olkaria II in Kenya). UNEP on the other hand has extensive experience with regional networking and technical assistance, and has its headquarters in Nairobi, Kenya. The Global Environment Facility (GEF) is a joint partnership between the UNEP, the UNDP and the World Bank to forge international cooperation and to finance activities addressing climate change among other global problems.

2.1 ARGeo components

ARGeo is based on four pillars: a regional network, a scientific advisory component, a financial risk mitigation instrument, and policy, regulation and transaction advice support as shown on Figure 1 below.

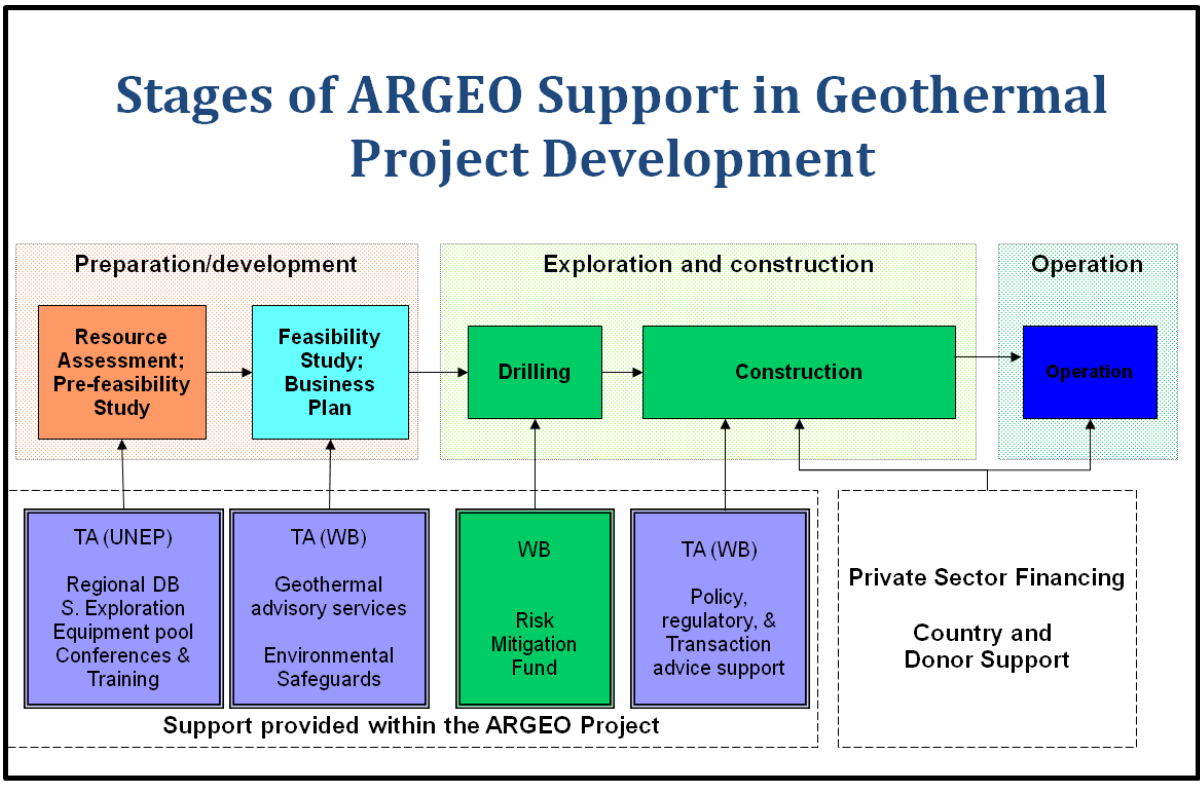

FIGURE 1: ARGeo project components

The regional network of geothermal agencies will not only deliver capacity building activities, build the information base in the region and promote clear policies and regulatory frameworks but will also promote a more effective use of resources and available expertise in the region and facilitate learning across countries. This will form the basis on which the other components will be built. Kenya will be an important source of expertise and equipment for the rest of the region. A strong argument for ARGeo's regional approach, aside from maximizing the use of regional expertise and the more effective use of resources, is the unified geological setting of the rift and the similar challenges in geophysical data collection and interpretation that countries are facing. Regional fora for exchanging information and experience, and for establishing contacts are therefore included as key project activities.

An important and unique aspect of ARGeo is its systematic and comprehensive approach that will address all the barriers, starting from the early stages of resource confirmation up to the preparation of bankable projects for priority prospects, and the transaction advice in the case of private sector investment.

The current project fund is about USD 18.6million. About USD 13million will be used for the risk mitigation while the rest will be used for the other components. In addition, Iceland will provide about USD 2.5million spread over five years for technical assistance and training, equipment pool management while BGR will provide about USD 2.8million up to year 2008 for various exploration projects in Ethiopia, Kenya, Tanzania and Uganda. Many of these projects have already been undertaken. The IAEA will provide assistance in isotope data analysis and laboratory assistance.

2.2 The regional network, surface exploration and training support (UNEP)

The activities under this component will be managed by UNEP. The regional network will deliver three main programmes as follows: a regional geothermal information exchange programme, a capacity building programme and a programme for the promotion of policies and legal and regulatory frameworks supportive of geothermal development. The network itself will consist of geothermal agencies in the region designated as focal agencies for ARGeo, and will rely on network hubs in the focal agencies supported by the facility, and on the Project Management Unit (PMU) located in the UNEP, Nairobi for coordination and outreach. In addition, a regional technical coordination group will provide an essential coordination mechanism at the regional level. The network hubs will be connected through a website already developed that will host a geothermal information database, directories and technical reports, a newsletter and project related information. Dedicated staff in each of the focal agencies supported by the GEF project funds will be responsible for maintaining the network and for the network coordination at the national level. The network will be designed as an instrument of cooperation and collaboration between institutions in each country engaged in geothermal resource related research, exploration and development.

The rationale for building a geothermal information base in the region is that the geothermal resource information in the region is generally scattered, unorganized and difficult to access, and thus forms an additional barrier to geothermal development. Many valuable reports and data collected during the 1980's exist only in hard copy and risk being lost. The experience with geothermal exploration in East and South East Asia for example has shown that a critical part of geothermal development is the adoption of a long term resource data collection plan and a systematic methodology of exploration and prioritization. It is believed that the ready availability of the information among a wide range of users in the region will be useful in progressing geothermal resource exploration in several areas starting from higher levels of knowledge.

The second element of strengthening the regional information base and promote learning is the organization of regional technical workshops and biannual East African Geothermal Conferences, as well as participation by experts from the region in international geothermal events. The rationale for this element is that working in the same geological environment, the professionals and technicians of the region have knowledge and experiences which are largely transferable and widely applicable within the region. Forums for the exchange of knowledge and experience will provide a platform for experience and information sharing as well as for regional cooperation, and will contribute towards the overall improvement of performance, whilst new knowledge and skills created or brought into the region can easily be propagated in this manner. The first ARGeo conference was held in Ethiopia in 2006 and the second one will be held in Uganda in November 2008 and the third will be in Djibouti in 2010.

Sustainable geothermal resource development is dependent on the existence of national technical capacities. This is well demonstrated by Kenya and countries like Philippines and Indonesia. Kenya has made considerable investments in its human resources. Although existing technical capacity varies among the countries, with Kenya strong in geophysics and environmental issues, and Ethiopia in geochemistry, many gaps exist that will need to be filled over the coming decade. The need to strengthen the human resource base in the region will be addressed through the provision of technical training by the UNU-GTP and other sources of training, the participation of geothermal professionals

in field operations to obtain practical experience, and the organization of short training courses in the region in collaboration with the UNU-GTP that respond to the specific needs of the countries. The first short course was held in collaboration with the UNU-GTP and KenGen in 2006 and has been held every year thereafter. The UNU-GTP and KenGen are discussing modalities of making the short course a permanent school for the region.

The third element of the regional component involves the mainstreaming of geothermal energy into the national and regional planning process and power development plans and the promotion of clear regulatory and legal frameworks supportive of geothermal development. The project will promote policy and legislative regimes that allow the integration of geothermal energy resources into overall plans of socio-economic development and specific energy development plans. The aim is to reduce the institutional and regulatory barriers to geothermal investments.

Collaboration with geological surveys and international, regional and national geothermal centers outside the region will be actively sought through the network to ensure that the best available expertise will be brought to bear on the regional network. The regional network activities will be fully integrated with and support the technical assistance and finance components of the project. The combined activities under this programme will directly support a number of geothermal investments in the region.

Supported by the regional network, a package of technical assistance and finance will be provided to bring the proposals to the pre-feasibility stage and to assist in preparation of bankable documents. This will include surface exploration to confirm the potential of priority prospects in each country. The latter will directly address the barriers related to resource confirmation. GEF grants will be available for a limited number of surface exploration campaigns and agencies like BGR will offer technical assistance in undertaking surface assessments. An assessment and expert review of the exploration results at each stage will be carried out in order to achieve high quality conclusions and to make the most efficient use of resources including equipment facilitated through the regional network. The sharing of equipment will be modelled on the IRIS-Passcal centre in the US, with which the project will seek affiliation to increase the size of the equipment pool. The geophysical equipment purchased under the JGI project in Kenya for example, will be deployed in the other countries under the ARGeo umbrella. Use of the JGI methodology will effectively map high permeability zones and lead to the location of high production wells that will increase the average well production in Kenya from 2.5 MWe to over 5 MWe. It is expected that the JGI methodology will directly contribute to the removal of resource exploration and assessment barriers and will therefore reduce implementation costs related to geothermal energydevelopment.

Where possible, the activities under this component will build on and link up with existing programmes and ongoing and planned initiatives with similar objectives at the national, regional and international level.

2.3 The risk mitigation, policy, regulatory and transaction advice support (WB)

The activities under these components will be handled by the World Bank. The financial investment risk barrier associated with the exploration and appraisal drilling phases will be reduced by the risk mitigation fund that will be established by the project with GEF and co-financier funds. It will provide guarantees that will allow public entities as well as private developers to undertake the most expensive and risky stages of geothermal exploration and appraisal drilling. The mitigation will provide partial compensation of the costs incurred in case of failure of wells drilled. Therefore, the rate of success of drilling will determine the rate of depletion of the risk mitigation fund. The structure of the drilling risk mitigation fund was originally designed by KfW and modified by the World Bank. Currently, the World Bank is working on guidelines and selection criteria of the pipeline projects to receive the risk mitigation fund.

A Geothermal Advisory Panel (GAP), to be selected under World Bank guidelines, will advise on eligibility of applications to the fund on the basis of surface exploration and previous drilling results. Applications from both private and public entities will be considered, under conditions which are transparent and the same for all applicants. A fixed premium kept at a relatively symbolic level will have to be paid by the applicant. The SAP will be an advisory body of the ARGeo Steering Committee with a wide scope of work and will be composed of internationally recognized experts, selected on the basis of their experience and knowledge of the geology of and geothermal activities in East Africa. Its role in the risk mitigation fund is to determine a project's eligibility, provide a scientific opinion on proposed drilling programmes, recommend that the risk mitigation covers part of eligible costs of the drilling or that further studies and information are required, and to determine when a well can be considered as a success or as a failure. The compensation of a failure will be 85% of the total drilling cost excluding local taxes and will cover exploration, appraisal and production wells. The organisation structure is shown in Figure 2.

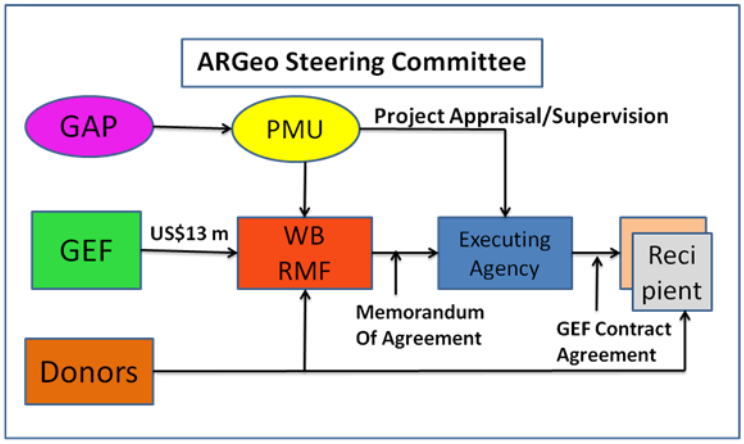

FIGURE 2: Risk Mitigation Organisation structure

At the investment stage, and in the case of private sector investment, the Transaction Advice will be provided by experts selected under World Bank guidelines in order to give neutral advice to the transaction process for geothermal investments from resources owners' responsibility to investors' responsibility. Support for policy and regulatory frameworks will be provided where required.

2.4. Project implementation arrangements

The ARGeo project will be executed by the Governments of the six ARGeo countries. Overall responsibility will be vested with the following National Executing Agencies (NEAs): Ministry of Energy and CERD (Djibouti), Department of Mines Ministry of Energy (Eritrea), Geological Survey of Ethiopia and the Ministry of Energy (Ethiopia), the Ministry of Energy and KenGen/GDC (Kenya), the Ministry of Energy and the Department of Geological Survey and Mines (Uganda), Ministry of Energy and Minerals (Tanzania). These agencies will implement the project in collaboration with other national government agencies, institutes and universities.

The UNEP will be responsible for overseeing the successful achievement of the project objectives and will also be the international executing agency for the regional network and technical assistance components of the project. The World Bank will be the executing agency for the risk mitigation fund and the transaction advice components. The UNEP will establish a Project Management Unit (PMU) in its headquarters in Nairobi, to handle the overall management, administration and financial management of the project.

A Project Steering Committee will be maintained at the international level to provide guidance to the project and monitor progress and performance. A Regional Network Coordination Group will be established comprising representatives from the National Executing Agencies, to ensure coordination at the regional level. The group will be supported by a network coordinator in the PMU.

In order to achieve a high quality and the most cost-effective pre-feasibility studies, an international scientific advisory and review panel will be established, comprising recognized regional and international experts.

Management and coordination of the project at the national level will be ensured through national project coordination units, and national project management and advisory groups.

3. PRIORITY PROSPECTS

A pipeline of priority geothermal prospects was prepared by each of the six countries for consideration by the project steering committee. The projects were as shown in Table 1, arranged in order of priority:

TABLE 1: Priority prospects

Djibouti	**Ethiopia**	**Uganda**
Assal	Tendaho	Katwe
N. Goubhet	Corbetti	Buranga
Gaggade	Tulu-Moye	Kibiro
Eritrea	**Kenya**	**Tanzania**
Alid	Longonot	Mbeya
Nabro-Dubi	Menengai	Rufiji
	Suswa	L. Natron-Manyara

In 2007, the available information on the submitted pipeline proposals was evaluated by a panel of experts selected by the World Bank. Further information was requested from three projects from Djibouti, Ethiopia and Kenya. Based on developed scoring criteria, the three projects were found to be ready for implementation. However, additional information on the economic viability and modelling was still required for a full appraisal before the projects can be approved for risk mitigation funding. Initially only one project is expected to be selected for consideration by the GEF CEO and the World Bank Board hopefully before the end of 2008. The projects from Eritrea, Tanzania and Uganda required additional exploration before they are considered in the next round of evaluation and selection.

4. CONCLUSION

It is clear that the formation of ARGeo has the potential of inspiring the geothermal activities in the East African Rift countries with far reaching benefits of installing over 1000MW of clean, indigenous renewable energy which can reduce pollution and promote poverty alleviation. Unfortunately, since its establishment in May 2003, no project has been funded although certain activities for example short course training by the UNU-GTP, some surface exploration by BGR, the development of a website and ARGeo conferences have been undertaken. ARGeo has also enabled the participating countries and the project agencies to come to a common and better understanding of the different components of ARGeo and has produced a pipeline of projects in the target countries, and quite detailed proposals for the network, technical assistance, and risk mitigation fund components. Meetings and conferences have built partnerships that will lay the foundation for the implementation phase of ARGeo.

The project is about to be endorsed by the GEF CEO when the first project to be covered by the mitigation fund is appraised by the World Bank which will mark the beginning of the project, hopefully before the end of 2008. Unfortunately, the project is currently underfunded. However, the funds available can start the project and the success of the first pipeline project is critical in attracting interest from potential funding agencies.

The project agencies will endeavour to link up and build on existing initiatives internationally, in the region and in the countries to ensure ARGeo's integration in on-going and planned programmes, and to build a true platform for geothermal development in Eastern Africa.

REFERENCES

Jamet, B., Verbeken, A. and Hamlin, T., 2005: Stimulating geothermal development in Eastern Africa. The establishment of the African Rif Geothermal Facility. *Proceedings world Geothermal Congress 2005 Antalya Turkey.*

Geothermal Energy Association, 1999: Geothermal Energy, the Potential for Clean Power from the Earth, *Preliminary Report*, 1999

US Department of Energy, 1998: Strategic Plan for Geothermal Energy Program.

UNEP, 2003: The African Rift Geothermal Development Facility, UNEP/GEF PDF-B Project Document, *GEF May Council Work Program*, (2003)

Ministere de I'Energie et des Resources Naturelles, Djibouti, 2004: Geothermal Development in the Republic of Djibouti: Project-pipeline Proposal for Implementation under ARGeo, *Unpublished*.

Kenya Electricity Generating Company Limited, 2004: Funding Proposal to ARGeo Geothermal Resource Assessment, Project for the Longonot Geothermal Prospect, *Unpublished.*

Geological Survey of Ethiopia, 2004: Project Proposals, Project1: Tendaho Geothermal Resource Development and Project 2: Surface Exploration in Five Prospect Areas and Development of Two Selected Geothermal Fields, *Unpublished*.

Ministry of Energy, Eritrea, 2004: ARGeo Geothermal Pipeline Project, *Unpublished* (2004) Ministry of Energy, Tanzania: Project Pipeline Proposal for Implementation under ARGeo, Geothermal Resources Development in the United Republic of Tanzania, *Unpublished*.