IRENA
International Renewable Energy Agency

GEOTHERMAL FINANCE AND RISK MITIGATION IN EAST AFRICA

Key findings from a regional workshop held in Nairobi, Kenya, 31 January – 2 February 2018

Geological diversity in East Africa calls for tailored approaches to geothermal energy development that address each country's specific challenges and opportunities. Generally, high upfront investment costs, regulatory gaps and competition from other energy sources create a challenging environment for geothermal projects in the region. Yet governments can play a key role in reducing the risk associated with geothermal energy projects through a variety of instruments. Sound policies and innovative risk mitigation mechanisms targeting the early phases of a project can be crucial to unlocking investment. Sound exploration, wellhead technology application and integrated resource use can also reduce risk and improve bankability.

Photograph: IRENA

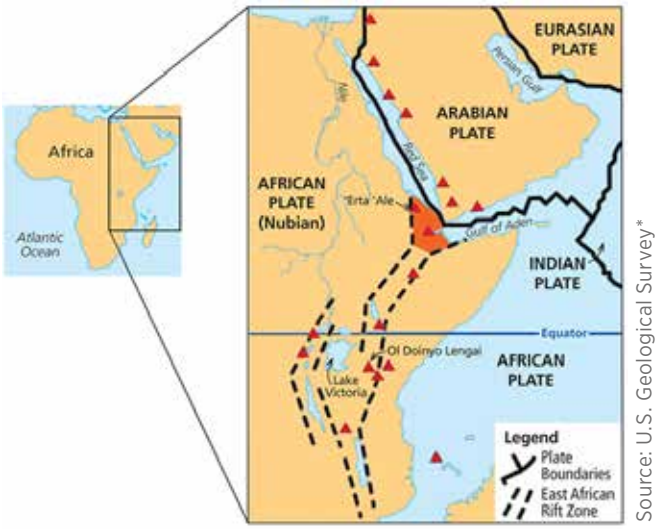
Introduction

The countries situated along the East African Rift System (EARS) are endowed with significant, yet largely untapped, geothermal resources. As of today, Kenya is the only country in the region with operating geothermal plants. However, given the accelerating interest in geothermal energy, the region could soon become one of the world's fastest-growing geothermal markets.

The Geothermal Risk Mitigation Facility, managed by the African Union Commission, aims to fund, facilitate and accelerate geothermal power development in the region. The Facility can cover up to 80% of the costs of surface studies, 40% of drilling and 20% of the early infrastructure costs. However, further complementary instruments may be required to realise the region's significant geothermal potential.

In this regard, a comprehensive overview of the barriers and risks at each phase of project development, a better understanding of how technical regulatory requirements impact the bankability of development projects, and an assessment of the mechanisms successfully applied in other regions may serve to inspire policy makers in East Africa.

Figure 1: The East African Rift System



Source: U.S. Geological Survey*

To this end, the regional workshop, "Geothermal Financing and Risk Mitigation in Africa", was convened in early 2018. The event was co-organised by IRENA, the Government of Kenya, the Government of Japan and the African Union Commission and allowed participants to share their experiences, innovative operational financing models and lessons learned.

The workshop was attended by around 100 participants, including appointed delegates from the governments of Burundi, Comoros, Djibouti, Egypt, Ethiopia, Kenya, Uganda, the United Republic of Tanzania, and Zambia, as well as key stakeholders such as project developers, development partners and managers of risk-mitigation facilities.

The agenda is provided as an annex, while the presentations are available online at: www.irena.org/events/2018/Jan/Regional-Workshop-on-Geothermal-Financing-and-Risk-Mitigation-in-Africa.

* *Disclaimer:* the boundaries and names shown on this map do not imply any official endorsement or acceptance by IRENA.

Key findings

1. Geological diversity across the East African Rift System calls for tailored approaches addressing each country's challenges and opportunities.

» With an installed capacity of 676 megawatts-electric (MWe), Kenya has led the region's geothermal development. Ethiopia has a pilot project installed but the plant is currently not in operation due to maintenance and other challenges. Several projects are at advanced exploration stages in Djibouti, Ethiopia and Kenya, while exploration for high and medium temperature geothermal resources has also been initiated in other countries. In addition, direct use of geothermal has been in place in the EARS region for a long time – notably for water harvesting and bathing– while a limited number of commercial and pilot projects for greenhouse heating, milk pasteurisation, aquaculture etc. are currently in operation in Kenya. Still, awareness regarding the potential of such applications remains limited.

» Experts reported that the eastern and western branches of the East African Rift differ in terms of their geological conditions and resources. The eastern branch of the rift (extending from Djibouti, Eritrea and Ethiopia through Kenya into northern United Republic of Tanzania) is primarily characterised by magmatic intrusion at shallow depths, while the western branch (extending from northern Uganda through Rwanda, the Democratic Republic of Congo, Rwanda and Burundi to southern United Republic of Tanzania, Malawi, Zambia and Mozambique) present little or no volcanos with shallow-seated magmas. Such geological diversity implies that the countries within the EARS vary in terms of geothermal potential, resource-related risks and potential end-uses. In turn, this implies that the exploration methods and risk mitigation strategies successfully applied in countries of the eastern branch, such as Kenya or Ethiopia, may not be directly applicable to countries situated along the western branch. In this context, several delegates underlined the importance of conceptual modelling in designing appropriate exploration plans and developing tailored support, including in terms of financial and technical assistance and capacity building. Some delegates also discussed the value of learning from past exploration and development failures in East Africa and elsewhere to inform future programmes and avoid wasted efforts.

2. High upfront investment costs, regulatory gaps and competition with other energy sources create a challenging environment for geothermal projects.

» Experts pointed out the various challenges for geothermal projects in the region, including:

- regulatory gaps, overlapping requirements between public authorities involved and lack of adequate policies in some countries;
- high upfront investment costs;
- commercial banks' reluctance to participate in the exploration phase;
- shortage of local human and technical capacities;
- lack of support for the exploration of low temperature resources; and
- competition with hydro, natural gas and distributed or off-grid solar systems as well as uncertainty regarding the timing and level of demand growth, which may favour energy sources with shorter development times.

» Also, some experts underscored the likelihood that the growth of baseload power will be driven by industrial demand. Thus, geothermal development could be linked to industrial strategies.

3. Governments can play a key role in reducing risks through a variety of instruments.

» Delegates highlighted that the deployment of geothermal energy requires some form of public intervention. There are a number of ways to structure such intervention, as reflected by the key business models for geothermal development with differing levels of cost-sharing between the public and private sector depicted in Figure 2.

» A peculiarity of geothermal projects – and especially those located in green fields – is the significant upfront cost for test drilling required before confirmation of resource presence, and therefore before project profitability can be determined. Consequently, several governments are involved in early-stage geothermal development, as this approach has been understood to reduce risks and keep tariffs low. Kenya and Ethiopia, however, have more than one model in place and, as demonstrated by the latest developments in these countries, this is helping to reduce risks and accelerate geothermal deployment.

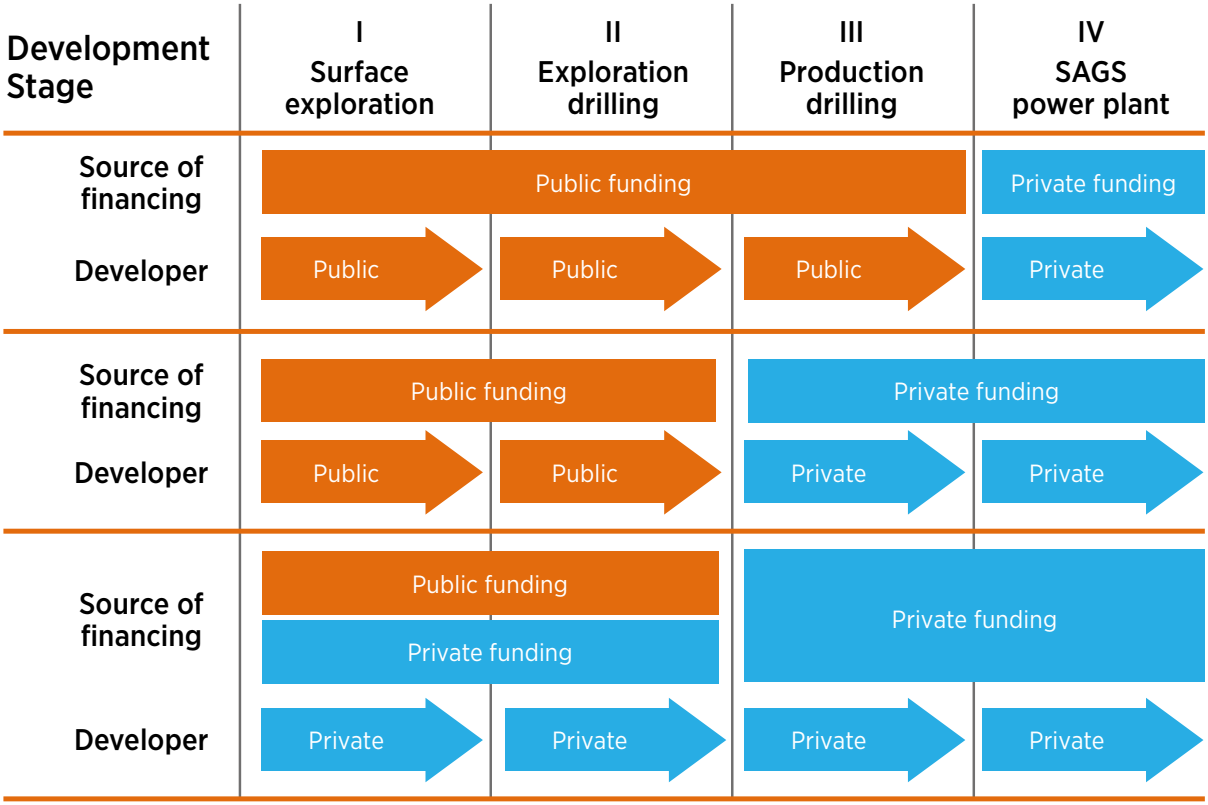
» Experts agreed that risk-sharing with governments, if properly chosen and executed, can offset some of the financial risks to private investors, thereby improving the attractiveness of a project. Nonetheless, some participants warned that the greater the role of government the greater the human and financial capacity needed. In this framework, several delegates pointed out the critical importance of capacity building for the public sector, which must be tailored to a government's chosen business model.

» Representatives from the private sector pointed out that a bankable project requires a power purchase agreement and an implementation agreement. In this regard, a leading geothermal project developer active in the region stated that a project will only be deemed "bankable" once the lender is certain that the borrower can repay the debt and the off-taker benefits from the purchase by paying a competitive and sustainable tariff.

» Furthermore, participants agreed that governments can help reduce risks and attract private investment by establishing, in advance, clear and transparent licensing requirements and mechanisms to ensure a return on investment. The costs associated with burdensome administrative procedures can also be reduced through the establishment of one central agency dealing with the public ministries on the one hand and the developer on the other. In this context, enabling policy and regulatory frameworks should be developed in consultation with the private sector.

» Finally, the recent developments in Ethiopia suggest that a bankable power purchase agreement is key to enabling private investment in the absence of a comprehensive regulatory regime.

Figure 2: Cost-sharing modalities in geothermal development



* SAGS: steam above-ground pipeline system.
Source: Presentation by Thrainn Fridriksson, "Comparative analysis of approaches to geothermal resource risk mitigation", ESMAP/World Bank.

4. Innovative risk mitigation mechanisms targeting the early phases of a project can be crucial to unlocking investment.

» Risk mitigation instruments already available in the region and worldwide were reviewed during the workshop. The participants pointed out that existing direct finance options – for example from the Geothermal Risk Mitigation Facility – have been important in attracting interest from the private sector and improving the understanding of the geology through the financing of surface studies. However, several experts and government representatives said that the time and effort required to complete the application process was onerous, owing to their limited staffing and experience.

» Furthermore, equity and other funding for appraisal drilling, together with public–private well productivity insurance schemes, could further encourage private sector involvement and facilitate the successful development of geothermal projects, including from low and medium temperature systems.

Regarding well-productivity insurance, experts stated that only a few geothermal power plants were developed globally using this instrument, with some failed attempts in Germany, Turkey and the United States. However, public–private risk mitigation insurance schemes, together with complementary investment and operating aid, have been successful in supporting the market uptake of geothermal heating projects in France and the Netherlands.

» High premium and transaction costs were reported to be obstacles for insurers due to small markets and the intense due diligence required by each project. However, efforts are underway to explore various insurance scheme designs such as a portfolio approach (insuring the specific productivity of several wells in a prospect) and backstopping by public concessional funds (e.g. Mexico). In this framework, the structure of the proposed Geofuture Fund depicted in Figure 3 was presented during the workshop. The proposal, which was shortlisted by the Green Climate Fund, promises to make it easier for developers in Kenya and Ethiopia to raise equity.

Figure 3: Geofuture fund proposal

Activity addressed	Pillar 1 Direct finance			Pillar 2 Risk mitigation		
	Coverage	Type	Sectors	Coverage	Type	Sectors
Surface studies	✓	40% CL	Any	✗	N/A	N/A
Infrastructure	✓	40% CL	Any	✗	N/A	N/A
Exploratory drilling	✓	40% CL	Any	✓	60% CL	Pri & PPP
Appraisal drilling	✗	N/A	N/A	✓	60% CL	Pri & PPP

Intervention type key

NRG	Non-recoverable grant
CL	Convertible loan
N/A	Not applicable

Sector key

Any	Any sector (public, private or PPP) eligible
Pri	Private sector eligible
PPP	Private private partnership eligible

Source: Presentation by Julian Richardson, "Innovative risk finance solutions: Insights for geothermal power development in Kenya and Ethiopia", www.irena.org/events/2018/Jan/Regional-Workshop-on-Geothermal-Financing-and-Risk-Mitigation-in-Africa

5. Sound exploration, wellhead technology application and integrated resource use could help to reduce risks and improve bankability.

Delegates to the workshop presented and shared experiences, lessons and innovative models to finance operations. The following elements, highlighted during discussion, could reduce risks and improve the bankability of geothermal projects:

- **Sound exploration for high-quality geological data:** prior to the more capital-intensive drilling phase, sound exploration through adherence to best international practices to conduct and manage surface surveys and thorough data analysis from the project site should be considered the first risk mitigation tools available. Dedicated appropriate technical assistance is undoubtedly critical to improving the quality and interpretation of geological data during the first phase of surface exploration.

- **Linking technical and commercial analyses** to the development of realistic pre-feasibility studies prior to making major investments.

- **Generating early revenue (or offset costs) through wellhead generators:** the application of wellhead technology has dramatically improved the economics of some geothermal projects in Kenya and elsewhere. Generated electricity from single production wells brings in cash flow early in the project and the possibility to relocate the plant once there is enough steam available for a more efficient, large scale power plant. As the operation of the wellhead unit becomes very important to assessing the economic feasibility of mobile wellhead power plants, its application should be carefully considered at the beginning of the field development.

- **Supplement project revenues through direct use applications and sale of other by-products** such as CO_2, silica, etc. Direct uses include aquaculture, horticulture and food drying, industrial processes, spas, etc., all of which can contribute to the development of economic activities in the areas nearby the resource location, thereby also facilitating social acceptance.

6. Capacity building will be vital to strengthen the decision-making process.

» Government agencies outside Kenya are short of technical and commercial expertise and experience (in areas such as geosciences, drilling, reservoir engineering, financial analysis, market analysis, project management and business planning).

» Delegates pointed out that training and overseas courses are only part of the solution, as lengthy courses create "brain drain" for small geothermal departments without imparting significant hands-on experience. In this framework, the first pan-African training centre for geothermal energy was presented. The centre is currently being established in Kenya under the leadership of the African Union.

» Some experts shared their experience with technical assistance in the region and highlighted the need for capacity building with mentoring support, technical training through live modelling, drilling and other activities, and commercial training for financial modelling and project management. Capacity building, therefore, should be focused on supporting decision making, not only imparting technical or commercial knowledge.

» Delegates from Egypt – invited to the workshop to represent an emerging market at the early stage of geothermal development – revealed that the country most needed support on the following aspects:

- mapping geothermal resources;
- technical and economic pre-feasibility analysis for identified sites, including for desalination and other applications; and
- related-capacity building for the New and Renewable Energy Authority's staff.

FURTHER READING

» Global Geothermal Alliance: www.globalgeothermalalliance.org

» IRENA: https://irena.org/africa

» Geothermal Risk Mitigation Facility: https://grmf-eastafrica.org/

» African Rift Geothermal Development Facility: http://theargeo.org

» East Africa Geothermal Energy Facility: www.eagerfacility.com/knowledge-hub

Annex: Original workshop agenda

Regional Workshop:
Geothermal Financing and Risk Mitigation in Africa

31 January–2 February 2018
Hotel Crowne Plaza, Kenya Rd., Upper Hill, Nairobi, Kenya

DAY 1:
31 JANUARY 2018

Welcoming remarks	
09:00 – 09:30	Paul Mbuthi, Ministry of Energy and Petroleum of Kenya Henning Wuester, International Renewable Energy Agency (IRENA) Masaomi Koyama, Ministry of Economy, Trade and Industry (METI) of Japan
Keynote address	
09:30 – 10:00	Eng. Benson M. Mwakina, Ministry of Energy and Petroleum of Kenya
Session I: Key challenges and opportunities in developing geothermal energy in East Africa	
10:30 – 12:30	**Moderator:** Salvatore Vinci, IRENA
	Scene-setting presentation:
	Geothermal outlook in East Africa, Peter Omenda, International Geothermal Association
Session II: Optimising frameworks to promote geothermal investments	
14:00 – 15:30	**Moderator:** Muhammed Adem Muhammed, Ethiopia Energy Authority
	Presentations:
	• *Geothermal transparency guide: Regulatory frameworks for geothermal exploration and exploitation*, Baldvin Björn Haraldsson, BBA • *Enabling investment in geothermal power in East Africa: Lessons learnt from the EAGER Facility*, David Sussman, East Africa Geothermal Energy (EAGER) Facility
Session III: Geothermal in power markets: How to ensure stable revenue streams?	
16:00 – 17:00	**Moderator:** Paul Mbuthi, Ministry of Energy and Petroleum of Kenya
	Scene setting presentation:
	Jon Orn Jonsson, Reykjavik Geothermal

DAY 2:
1 FEBRUARY 2018

Session IV: Risk mitigation instruments and practices	
09:00 – 10:30	**Moderator:** Luca Angelino, IRENA **Presentations:** • *Comparative analysis of approaches to geothermal resource risk mitigation,* Thrainn Fridriksson, World Bank, ESMAP/World Bank • *Geothermal Risk Mitigation Fund (GRMF) in East Africa,* Rashid Ali Abdallah, African Union Commission • From panel discussion: Hisanori Ogawa, Japan Oil, Gas and Metals National Corporation (JOGMEC)
Session V: From risk mitigation instruments to project implementation: How to fill the gap?	
11:00 – 13:00	**Moderator:** Peter Omenda, International Geothermal Association (IGA) **Presentations:** • *Innovative risk finance solutions: Insights for geothermal power development in Kenya and Ethiopia,* Julian Richardson, Parhelion • From panel discussion: Satoshi Sugimoto, Japan International Cooperation Agency (JICA) and Bertrand Belben, InfraCo Africa
Session VI: Geothermal project development and technical support	
14:00 – 15:50	**Moderator:** Thrainn Fridriksson, ESMAP/World Bank **Presentations:** • Markos Melaku, NZ-Africa Geothermal Facility • *IRENA Project Facilitation Tools*, Tijana Radojicic, IRENA • *Status of resource assessment in Egypt*, Tamer Mohamed Abdel Kader, New and Renewable Energy Authority of Egypt
Closing Remarks	

DAY 3:
2 FEBRUARY 2018

Field Trip	
07:30 – 15:30	**Visit to the Olkaria geothermal field** **Scene setting presentation:** *Geothermal exploration and development in Kenya,* Cyrus Karingithi, KenGen

Acknowledgements

The regional workshop "Geothermal Financing and Risk Mitigation in Africa" was co-organised by the International Renewable Energy Agency (IRENA), the Governments of Kenya and Japan, and the African Union Commission. IRENA is grateful for the generous support of the Ministry of Economy, Trade and Industry of Japan.

Peter Omenda (International Geothermal Association) and Gurbuz Gonul (IRENA) provided valuable feedback on this brief. Luca Angelino and Salvatore Vinci (IRENA) prepared the brief.

www.irena.org