Risky business:: developing geothermal power in Kenya

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Introduction

Expansion of geothermal power is a major component of Kenya's nationally determined contributions (NDCs) to global climate change mitigation and integral to the country's ambition to become a middle-income country based on a climate-resilient green economy (Government of Kenya 2007; Ministry of Environment and Natural Resources 2015). The government's Least Cost Power Development Plan 2017–2037 and third Medium Term Plan (2018–2022) both envisage a four-fold expansion of geothermal power generation from 650 MW to around 2500 MW in 20 years (Government of Kenya 2018).[1]

Abundant, low-carbon and climate-resilient, geothermal power is an attractive resource, with potential for additional heat applications in industry. As geothermal resources have been increasingly exploited over the past four decades, considerable technical expertise on geothermal has been established within the country's state-owned utilities and ancillary services. However, attracting the private investments needed to develop the country's geothermal resources at a swifter pace remains a challenge, hindered by a number of financial, political, social and environmental risks.

In this brief we explore these risks to identify issues that need attention if accelerated geothermal development to stimulate the national economy is to be matched by benefit-sharing with local communities, effective conservation of protected areas and stimulation of local economic development. The brief is based on 17 interviews and three focus group discussions with geothermal-sector stakeholders, as well as field observations and a review of documents, undertaken between October 2016 and February 2018.

Powering the nation with steam

Geothermal development typically encompasses roughly six phases, taking place over up to a decade (see ESMAP 2012; Ng'ang'a 2005). It starts with geo-exploration through surface studies followed by exploratory drilling, a practice that involves drilling three to six narrow wells to about 2000–3000 meters. Once a steam field has been identified and the resource is proven viable, around a dozen production wells are drilled to extract steam, and a system of pipes is constructed to gather it at one location and to then reinject it back into the steam field reservoir. The gathered steam is most commonly used indirectly in a steam turbine for power generation. It can also be used directly for a range of heat applications, such as spas, district heating, and industrial and smaller-scale processes requiring heat. In the case of steam turbine power generation, power is typically transmitted and distributed through the national grid to residential, commercial and industrial

Photo (above):
KenGen engineers monitor power generation at wellhead in Olkaria.
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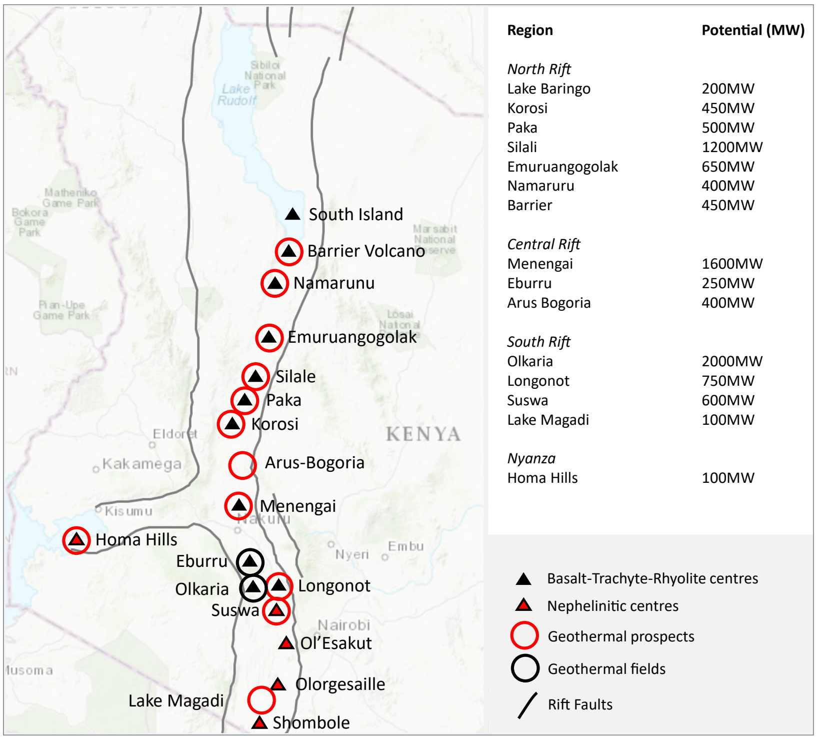
1 See also www.mtp3.go.ke

Figure 1. Map of geothermal resources in Kenya



Region	Potential (MW)
North Rift	
Lake Baringo	200MW
Korosi	450MW
Paka	500MW
Silali	1200MW
Emuruangogolak	650MW
Namarunu	400MW
Barrier	450MW
Central Rift	
Menengai	1600MW
Eburru	250MW
Arus Bogoria	400MW
South Rift	
Olkaria	2000MW
Longonot	750MW
Suswa	600MW
Lake Magadi	100MW
Nyanza	
Homa Hills	100MW

Source: Author's own based on Government of Kenya (2011)

end users. In both cases, careful management of the steam field is crucial to ensure the resource is not depleted and that hazardous chemicals in the steam are properly managed. As yet, no geothermal steam fields or power plants have been decommissioned in Kenya.

Kenya's geothermal resource is located within the Rift Valley area, with recent estimates suggesting a resource potential of between 7000 MW and 10 000 MW spread over 14 sites (Ngugi 2012). Exploration in the Olkaria steam field began in the late 1960s to mid-1970s, undertaken by the state-owned Kenya Power Company Limited and supported by UNDP. This exploration led to the drilling of production wells in the Olkaria I block and commissioning of a 15 MW geothermal power plant – Olkaria I – in 1981. Drilling continued, with up to 20 wells added by 1985, and two additional 15 MW power plants were commissioned in 1982 and 1985 (Omenda and Simiyu 2015; Riaroh and Okoth 1994; Simiyu 2008).

Reform of the power sector in 1997 led to the unbundling of Kenya Power Company Limited into two entities: Kenya Power and Lighting Company (KPLC) – later rebranded as Kenya Power – responsible for transmission and distribution; and Kenya Electricity Generating Company (KenGen) responsible for generation (Kapika and Eberhard 2013; Karekezi and Mutiso 2000). Further unbundling occurred in 2008, with the establishment of the Kenya Electricity Transmission Company (KETRACO) as the state-owned electricity transmission utility. Kenya Power remained the "offtaker", the body that signs power purchase agreements with state-owned and private geothermal power-plant owners and distributes the generated electricity to end-users.

In its new form, KenGen remained in control of the Olkaria I block and began drilling in Olkaria II. In the meantime, the first private-sector concession was awarded to OrPower4 in 1998 to explore and develop Olkaria III. Additional Olkaria II steam turbine units were commissioned in 2003 and in 2007. The 140 MW Olkaria IV units 1 and 2 were commissioned in 2014, followed closely by Olkaria IV units 4 and 5 (140 MW each) in 2015. And current work is ongoing to develop another 165 MW in Olkaria V, expected to be commissioned in 2019 (Kenya Power 2018; Ngugi 2012; Omenda and Simiyu 2015; Ritcher 2018).

Since serious geothermal exploration first began 40 years ago, geothermal has evolved from niche technology and resource to major contributor to the national electricity mix

In 2009, the government established the Geothermal Development Company (GDC), with the mandate to accelerate geothermal development by guiding private sector investment and shouldering the burden of risky and expensive exploratory drilling (Ngugi 2012). GDC is currently developing a geothermal field in Menengai, providing steam sales to three independent power producers (IPPs) – OrPower22, Sosian Energy and Quantum Power – each of which will each build, own and operate a 35 MW power plant (Musembi 2014). Other fields are promising, but much hinges on progress in Menengai (Ministry of Energy and Petroleum 2013; Ngugi 2012)

Risks to accelerated geothermal development

Since serious geothermal exploration first began 40 years ago, geothermal has evolved from niche technology and resource to major contributor to the national electricity mix, with an installed capacity of 652 MW, providing almost half of Kenya's power (Kenya Power 2018). But a decade on from the establishment of GDC, the promise of accelerated development of geothermal has not been met. Indeed, Kenya's updated least-cost power-development plan estimate, geothermal capacity is projected to reach over 1 869 MW by 2030 (Government of Kenya 2018), a lower estimate than the initial targeted capacity of 5 530 MW in 2031 (Government of Kenya 2011). Below, we identify a set of key financial, political and social risks that continue to create barriers to accelerating geothermal development in Kenya.

Financial risks

High exploration costs. Geothermal development on "greenfield" sites – where no previous development has taken place – requires considerable upfront investment. One exploration well costs over USD 1 million to drill, and three wells are required simply to prove the resource. This high investment is prohibitively risky for both private companies looking to ensure a return on investment and state-owned utilities with limited budgets. In Olkaria, representatives from KenGen and OrPower admit they have been very lucky to find steam so easily and that the quality of steam has remained consistent for so long. This might not be the case elsewhere in the Rift Valley, and delays faced by private companies in Akiira and Longonot show the difficulty in finding investors patient enough to finance additional exploration. Stakeholders highlight that GDC was created precisely to bear this risk on behalf of the private sector – to undertake exploration and develop steam fields in greenfield sites and sell the steam to independent power producers, which invest in power generation only.

Drilling production wells in Olkaria, 2-3km below the surface
© OLIVER JOHNSON

High power plant infrastructure costs. But even once the resource is proven, the financial risk does not disappear. Typical costs for a 20 MW geothermal power plant – including production wells, the steam gathering system and steam turbine technology – can reach almost USD 80 million (GEOCOM 2015). Recent slow growth in demand, due to limited economic and industrial development,[2] has led to growing concern among government and Kenya Power officials that they will not have enough customers to be able to pay for the electricity that the company has agreed to purchase.

With careful management of steam reservoirs – as is currently the case in Olkaria – geothermal is a renewable source with little financial burden once initial capital costs are paid back. This results in competitive electricity tariffs that can help to reduce consumer cost of electricity, as already experienced in Kenya.

Political risks

Offtaker viability and power purchase guarantees. The financial risk associated with potential inability of the offtaker – Kenya Power – to pay for electricity it has contractually agreed to purchase is a key political and institutional risk facing the geothermal sector. Usually, the utility company would sell the power and pay for its obligation, but slow growth in large commercial consumers has resulted in surplus power. This may, in turn, greatly increase the cost of borrowing capital for investment. In the private sector, investors with a high tolerance for risk may be more amenable to investing in geothermal, but they typically require strong guarantees before they are willing to lend to greenfield project developers or independent power producers. In Menengai, GDC developed the geothermal field, and will sell steam to three IPPs. To mitigate investment risks, the IPPs have a project and steam sales agreement with GDC to guarantee the steam they will receive, and a power purchase agreement with Kenya Power to buy the power they produce. But delays in closing financing for the IPPs have continued as letters of support from the government have been slow in forthcoming, leaving some

2 E.g. a number of plans under Vision 2030 – such as electrification of the new Mombasa-Nairobi railroad, establishment of the hi-tech Konza City, and development of industrial parks close to geothermal sites – have so far failed to materialise.

political risks unresolved. Investors, private developers and government stakeholders all appeared to have very different perspectives on who should bear which risk. As such, geothermal remains dominated by grants and concessional loans (high interest and long payback periods) from development finance institutions, such as the European Investment Bank, the KfW Development Bank, the World Bank and Japan International Cooperation Agency (JICA).

Bureaucracy at national and county levels. County government representatives felt that too much national control was a risk to their ability to manage their own affairs and ensure that the voice of county citizens was represented. National government representatives viewed added bureaucracy and potential for political manoeuvring as a risk to project development and approval, which many deemed was already too convoluted. Meanwhile, private developers sat on the fence, appreciating the role county government could play in managing local issues, but remaining wary that increased levels of bureaucracy might lead to increased avenues for corruption, which already pervades so much of the Kenyan economy. The 2017 Energy Bill, still awaiting final approval, may do much to clarify the allocation responsibilities amongst national and county governments; however, limited capacity at the county level, and ambiguities in the details will take years to resolve.

Social and environmental risks

Community opposition. Construction of geothermal sites and associated transmission lines to connect these sites with distant demand centres, such as major cities and industrial areas, faces risks of community opposition. In the face of relocation – which occurred in 2010 to facilitate development of the Olkaria IV power plant – or other restrictions on land use, communities are understandably often resistant to geothermal development. Geothermal is not special in this regard;

Olkaria I and IV power plants © OLIVER JOHNSON many other large energy infrastructure projects, including various wind power and transmission line projects, have faced community opposition, spanning from written complaints to roadblocks and open protests. Government, state-owned utilities, and private project developers take community concerns seriously. For example, GDC has enlisted support from the New Zealand government in how to manage engagement with indigenous groups on infrastructure development and land issues: the two countries have had some common and comparable experiences (Shortall et al. 2015). Meanwhile, development partners, such as the World Bank, place considerable pressure on their projects to minimise social risks and show compliance with international standards, such as the Equator Principles.[3] Efforts to ensure the local community shares some of the benefits of infrastructure development typically include compensation, relocation to upgraded housing and additional community facilities, and job opportunities for unskilled labour in project construction and post-construction security. But the complex financing arrangements of geothermal projects often impede or limit on-the-ground implementation of international standards of development finance (Ole Koissaba 2018). The benefits are often incomparable to the losses, or unevenly distributed: for instance, it might be impossible to weigh improved access to a medical clinic with loss of fertile land for grazing livestock.

Power generated at the wellhead in Olkaria © OLIVER JOHNSON

While the urban middle-class, industries and manufacturing businesses benefit from cheaper and more reliable electricity, access of local communities to training and skilled employment at geothermal sites might remain limited. The new Energy Bill currently awaiting final approval will establish a community fund for development activities, which is likely to help significantly to achieve greater benefit sharing (Government of Kenya 2017). But until this comes into being and is proven to help, it remains unclear whether devolved government – with its added layer of political dynamics – will mitigate or exacerbate social impacts.

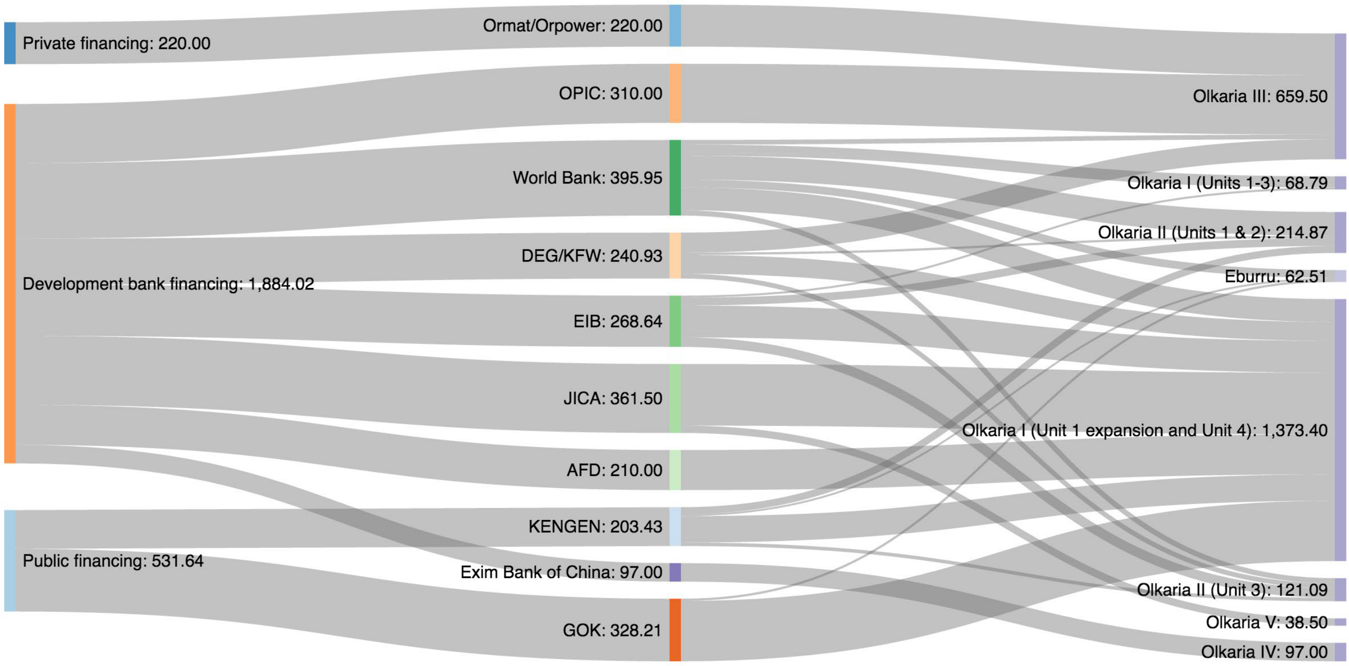
Opposition from conservation groups. The environmental risks of upscaled geothermal development include contamination from poor handling of toxic chemicals in the steam; withdrawal of water from lakes, rivers and wells beyond their capacity; and degradation and disruption to natural habitats and migratory routes of wildlife inside and outside protected areas (see Kubo 2003; Mariita 2002; Mwangi 2005; Ogola et al. 2012). These risks are largely the concern of conservation groups and others who depend on clean and available land and water resources. They can be – and often are – allayed by enforcing extensive environmental impact assessments and strong risk mitigation measures, such as controlled reinjection of steam into reservoirs; regulated water withdrawal; wildlife-friendly steam piping design; use of noise-reduction technology; and cautious management of toxic chemicals using the latest technology and processes. However, non-compliance can result in severe impacts. The situation calls for extra measures to enforce the set regulations, and perhaps to do more to publicly commend those who pursue best practices.

Uneven distribution of risks

Geothermal power generation is a large-scale industry, boasting only a few main actors that are part of, or fit well into, the existing centralised electricity system. Transmission and distribution of geothermal power is similarly large in scale with limited actors. The technological capabilities

3 See equator-principles.com.

Figure 1. Sources of finance for geothermal development in Kenya



Source: Author's own based on Micale et al. (2015) and Saitet and Muchemi (2015)

required for upscaling geothermal power lie partially within Kenya, where there has been significant accumulation of expertise and process innovation. And foreign firms possess the most advanced technology used in drilling and power generation, and the most sophisticated knowledge of steam reservoir modelling and steam field management.

There remain considerable challenges to obtaining finance for upscaling due to perceived financial, political and social risks of geothermal development. Many of the financial risks fall upon private investors and project developers seeking to invest debt and equity into exploration, drilling, and power generation ventures. Investors and developers are typically willing to shoulder risks that are internal and inherent to the project, such as those related to failing to prove the steam resource. But in order to mitigate against political risks, such as inability of the offtaker to meet the terms of the power purchase agreement, or nationalisation of private assets, they often seek guarantees from the national and county governments that their investments will be protected.

KenGen engineer explaining geothermal power generation at Olkaria IV © OLIVER JOHNSON

The social and environmental risks of geothermal power development are largely borne by local communities, which are rights holders of the land where the activities generally occur. Kenya's strong land rights mean that traditional communities even maintain some access rights on privately-owned lands. Because the livelihoods of many of these communities is so closely tied to the land, the national and county governments – as duty bearers for the citizens they govern – have a responsibility to uphold these rights (particularly where the capacity of rights holders to manage social and environmental impacts is limited). This requires effective regulation of private project developers and state-owned electricity utilities.

Environmental and social impact assessments, with associated resettlement action plans, are the typical tools used by duty bearers to hold private economic interests accountable for minimising risks to local communities. But there is potentially a greater role for monitoring by local citizens who might be better placed to identify changes in their local communities and environment.

The distribution of risks among powerful and marginalised stakeholders affects how these risks are weighed against benefits when decisions are made (or not made). The financial benefits accruing to private companies or government from the sale of electricity, along with the political benefit of ensuring reliable power from a clean energy source for the middle and elite classes, appear to have much more weight than the concern over the livelihoods of a few local communities with little influence. But with devolution and the prospect of greater benefit-sharing, more weight may be given to those local concerns by the county government.

Conclusions

This brief explores the risks to accelerating geothermal power development, widely viewed as a core element of Kenya's low-carbon and climate-resilient development ambitions. Optimism around the potential for greater geothermal power development needs to be tempered with serious action to mitigate social and political risks. Geothermal development in Kenya has largely focused on nurturing a new industry and building technical expertise. But, as the sector has grown, so too have the challenges it faces, placing increased pressure on both the government and the private sector to pursue further development in a responsible manner and ensure the benefits of geothermal development are shared equitably. Our analysis shows that risks and benefits accruing to those marginalised stakeholders located close to geothermal resources, and who were often the poorest of all stakeholders, tended to be given less weight than the risks and benefits accrued by those in positions of relative economic and political power.

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Relocated local pastoralists continue to graze their livestock in Olkaria © OLIVER JOHNSON

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