



INSIDE STORIES

on climate compatible development

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Key messages

- Kenya has relied on hydroelectricity as a key low-carbon energy source and a way of expanding energy services. However, droughts and erratic rainfall have made hydro-power unreliable, reducing the country's adaptive capacity. Nearly 77% of Kenyans still lack access to modern energy services, which impedes development efforts.
- Kenya's *Vision 2030* prioritises low-carbon development. An expanded and diversified range of renewable electricity sources is critical, and geothermal energy is at the forefront of low-carbon options. Geothermal is readily available and is not affected by climatic variability.
- Kenya has catalysed a productive geothermal sector by establishing a specialist government institution, the Geothermal Development Company, which shoulders some of the financial risk for the private sector at exploration, appraisal and drilling stages.
- Kenya has accessed previously unattainable funding sources by aligning further investments in geothermal energy with climate change and development objectives (e.g. carbon/climate finance, donor funding and local public finance).

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Harnessing geothermal energy: The case of Kenya

Kenya's heavy reliance on hydroelectricity production has made the country vulnerable to climate change impacts, such as drought and erratic rainfall patterns. Kenya needs to develop a more resilient and stable supply of electricity, while rapidly developing its base load of electricity production to meet growing demand. Although the path of least resistance would be to expand its fossil fuel-based thermal production, Kenya's *Vision 2030*¹ strategy places priority on low-carbon development including renewable energy development – with geothermal playing a critical role.

Energy sector reforms in Kenya are beginning to stimulate and fast-track the country's geothermal industry in line with the country's vision of climate compatible development. The country is finding ways to overcome constraints within the sector and obtain project financing. This is supported by several enabling factors and concrete measures taken by the Government of Kenya (GoK) with the aim of creating a viable and sustainable national geothermal industry.

Kenya's electricity mix

The three main sources of electricity generation in Kenya are hydropower, diesel thermal and geothermal plants, along with several minor sources.

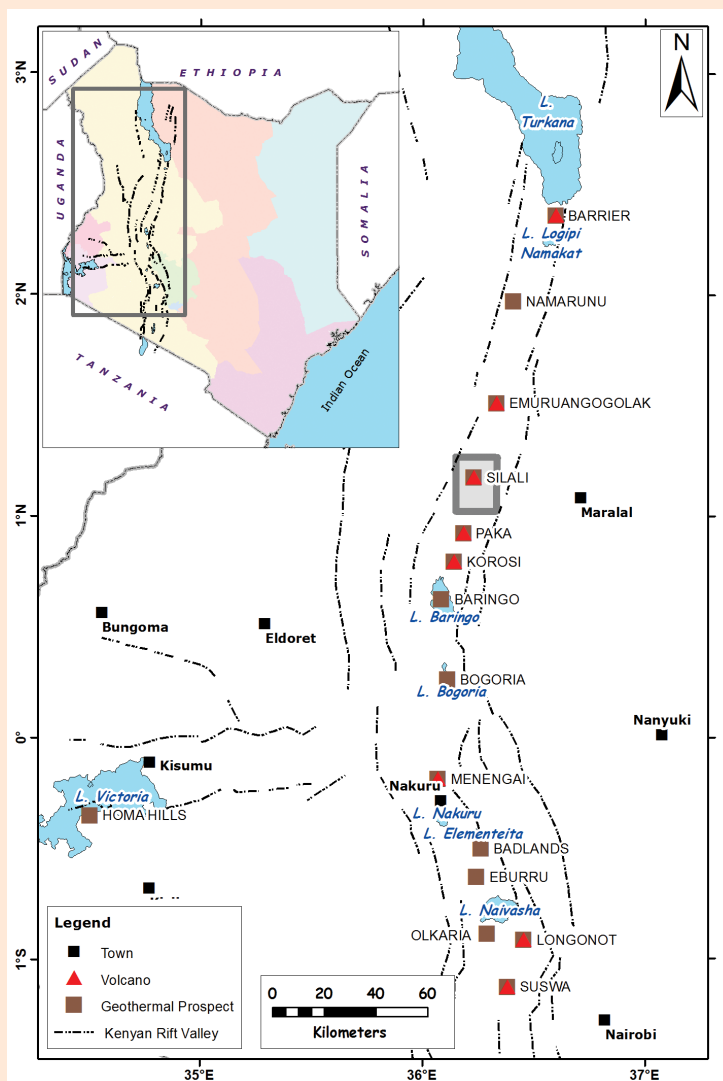
From 2004 to 2011, increases in electricity supply generally came from fossil fuels and geothermal (see Table 1²⁻⁴). Geothermal has shown the greater proportional increase in installed capacity (58% compared to 45%), despite the fact that set-up costs are significantly higher than for fossil fuels. Launched over 50 years ago, geothermal energy is only now emerging as a significant electric power resource for Kenya. Assessments of geothermal hotspots indicate an estimated potential of 7,000–10,000 megawatts (MW) in the Kenyan Rift Valley (Figure 1).^{5,6} By 2030, the GoK intends to tap into its rich geothermal potential, drastically increasing geothermal capacity to twice that of fossil fuels. Hydropower production is projected to remain relatively stable.

Table 1. Changes in installed capacity of the three main electricity sources in Kenya, 2004–2011

Electricity source	Installed capacity in 2004 (MW)	Installed capacity in 2011 (MW)	Increase in installed capacity 2004–2011 (MW)	Increase in installed capacity (%)	Installed capacity Vision 2030 (MW)	Increase in installed capacity 2011–2030 (MW)	Increase in installed capacity (%)
Domestic hydro	677	762	85	13	1,039	277	36
Geothermal	125	198	73	58	5,530	5,332	2,693
Fossil fuels	407	590	183	45	7,015	6,425	1,089

Sources: Column 1, Ministry of Energy (2004); Column 2, Ministry of Energy (2012); remainder of data in table GoK (2007).

Figure 1. Geothermal hotspots in the Great Rift Valley, Kenya



Source: Based on Ministry of Energy (2011) and Kenya Electricity Generating Company Ltd. (2006).

Why geothermal in Kenya?

Kenya has put the energy sector at the forefront of its long-term strategic planning because many Kenyans still lack access to modern energy services: it is estimated that 77% of Kenyans are not connected to the grid.⁷ At the same time, demand for electricity is rising due to Kenya's economic growth. The strategy for increasing renewable energy in Kenya to meet this demand highlights wind, solar, small hydro, biomass and geothermal as key sources, with geothermal being promoted most strongly:

“Geothermal has numerous advantages over other sources of power: it is not affected by drought and climatic variability; it has the highest availability at over 95% (i.e. relatively no intermittence); it is green energy with no adverse effects on the environment; it is indigenous and readily available in Kenya, unlike thermal energy that relies on imported fuel. This makes geothermal the most suitable source for base load electricity generation in the country.”⁸

The role geothermal energy plays in climate change mitigation and adaptation offers exciting synergies, such as the introduction of adaptation

benefits in emissions reduction projects (both voluntary and within the Clean Development Mechanism) and the use of afforestation and/or reforestation projects to improve the recharge of geothermal systems in drought-prone areas.⁹

Development benefits of geothermal energy

The development benefits of geothermal energy stem from both direct and indirect uses, namely the provision of heat and increased access to electricity, while also enhancing resilience to climate change impacts.

Direct uses of geothermal energy usually occur within a 50 km radius and include eco-tourism (hot baths and spas), small-scale liquid and dry milk processing (pasteurisation, etc.) and agriculture (greenhouses, crop drying). For example, the Kenya Electricity Generating Company (KenGen) supplies steam from its geothermal power station to Oserian Company in Naivasha to grow flowers and leguminous crops, and the Hell's Gate Natural Health Spa at Olkaria aims to boost tourism in the area.

Indirect uses of geothermal energy arise mainly through electricity production. Benefits related to rural electrification are widespread and well documented. Access to electricity in Kenya *“simultaneously enables and improves the delivery of social and business services from a wide range of village-level infrastructure (e.g. schools, markets and water pumps) while improving the productivity of agricultural activities”*.¹⁰

A recent study on the eastern Baringo lowlands in Kenya discussed the potential of geothermal energy to reduce climate change impacts, particularly the detrimental impacts associated with recurrent droughts, which were causing water levels and flow to fall below critical thresholds for hydropower production. It concluded that *“the use of geothermal energy will improve food security, create employment, reduce drought-related losses and provide alternative source of income streams”*.¹¹

Kenya taking action

The GoK has made widespread sectoral reforms, focusing specifically on promoting the development of renewable energy generation in Kenya.

Sending the right policy signals

A commitment to renewable energy has been made by the GoK through several policy developments, such as introducing feed-in tariffs, supporting public-private partnerships and backing loans. These have created a supportive policy framework for investment in renewable energy, once again with geothermal production at the heart of it. The feed-in tariffs policy, which was introduced in 2008 and revised in 2010, is already showing signs of

trickle-down effects. For instance, some sugar companies have plans to upgrade their biomass co-generation capacity because of expected savings.¹²

Getting the right institutions in place

The Energy Act of 2006 created more specialised institutions for the energy sector, as all energy sector functions had been previously centralised within the Ministry of Energy and the Kenya Power and Lighting Company. These reforms also contributed to the establishment of the Geothermal Development Company (GDC) to undertake integrated development of geothermal energy. It should also be noted that the Geothermal Resources Act of 1982 has had significant implications for these institutions and the sector.

The GDC is a semi-autonomous state-owned company, formed in 2009 under the Companies Act as a special-purpose vehicle to fast-track the development of geothermal resources. With a target of 5,000 MW of installed capacity by 2030, the GDC's mandate is to mitigate financial risks in the early stages of geothermal development – exploration, appraisal and production drilling – as the private sector is unable to absorb these risks. It also provides geothermal steam to power plants, ensuring they produce a more consistent and cost-effective electricity supply.

The GDC's achievements include:

- i. Building in-country capacity: A Geothermal Training Centre formed in partnership with Iceland offers technical training in geochemistry, geophysics and drilling engineering.
- ii. Attracting donor funding: The Menengai field alone has the

Provision of cheaper and environmentally friendly power, economic growth and creation of employment opportunities are some of the key benefits of geothermal energy utilisation.

GG Muchemi,
Geothermal Development Manager, KenGen

Establishing the GDC to take upfront risks of geothermal development (exploration and production drilling) has helped Kenya make positive strides in building a geothermal industry.

Mitsunori Motohashi, Energy and Financial Expert, World Bank, Kenya

potential to produce 1,650 MW, which is a major draw for donors.

However, the GDC faces challenges, such as:

- i. Competing sectoral developments: Due to a limited pool of highly skilled workers in Kenya, GDC has to be competitive with KenGen, for example, to attract Kenya’s brightest minds.
- ii. Difficult geology: Since the Menengai field has a difficult geological formation, geology experts are forced to drill directly into volcanic rocks.

Constraints

While progress has been made, Kenya still faces several constraints preventing it from further developing geothermal electrical production. From the identification of exploration sites to the commissioning of an active power station, the entire process in Kenya has been slower than expected. In 56 years, geothermal development has yielded only 207 MW of installed capacity, with an average annual increase of 4 MW.¹⁰ Limitations to geothermal energy development include:

- There is reluctance from investors to fund the high-risk early development stages. Geothermal developments

Table 2. Sources of financing available for geothermal energy development

Source	Requirements	Limitations	Financing institutions
Donor funding	<ul style="list-style-type: none"> • Sovereign guarantee • Feasibility study 	<ul style="list-style-type: none"> • Debt covenants • Sovereign guarantee • Country limits/risks 	<ul style="list-style-type: none"> • World Bank • Multilateral development banks • Bilateral donors
Venture capital	<ul style="list-style-type: none"> • Feasibility study 	<ul style="list-style-type: none"> • Sovereign guarantee • Mandatory equity 	<ul style="list-style-type: none"> • Actis, Aeros, Globeleq
Investment banks	<ul style="list-style-type: none"> • Sovereign guarantee • Feasibility study 	<ul style="list-style-type: none"> • Mostly finance public-private partnerships and private companies 	<ul style="list-style-type: none"> • IFC, Proparco, DEG
Sovereign funding	<ul style="list-style-type: none"> • Country priority project 	<ul style="list-style-type: none"> • Might not be country priority 	<ul style="list-style-type: none"> • Government funding for drilling
Carbon markets	<ul style="list-style-type: none"> • Additionality • Feasibility study • Project design • Document validation/ verification 	<ul style="list-style-type: none"> • Delay between upfront transaction costs and revenue stream from issuance of credits • Low/uncertain carbon price 	<ul style="list-style-type: none"> • World Bank BioCarbon Fund • Private investors & project developers • Donors (upfront transaction costs)

require huge upfront investment costs and drilling can yield wells that generate little or no steam. As returns for this phase are highly uncertain, multilateral, bilateral and private entities are generally unwilling to invest in exploration and appraisal, preferring to commit funds for production drilling and power plant construction.

- Project sponsors require a guarantee if the project is deemed to be high-risk. Dry wells and volcanic hazards make geothermal power exploitation a high-risk activity, and perceived country risks (e.g. political instability, challenges to doing business) can exacerbate this. Financial institutions are unwilling to insure such investments, making the electricity too expensive to be competitive.
- There is a very limited pool of experts with the technical capacity and skills in this specialised field.

Geothermal development is a highly specialised field, requiring the specific technical expertise of geoscientists and engineers – expertise that is limited in Kenya.

Financing sources

Renewable energy development in Kenya is financed by the government, development partners and the private sector (see Table 2). The government finances energy development via the national budget, while development partners provide loans and grants. Alternatively, the private sector uses debt and equity to fund its geothermal projects. Debt financing occurs when a firm raises capital by selling bonds, bills or notes to investors; in return for lending money, the creditors are promised repayment of the principal and interest. Equity financing raises money for company activities by selling stocks to investors. In return, shareholders

receive ownership interests in the company. Risk guarantee facilities, like ARCgeo and AUC-KfW, have provided financial mechanisms for the high-risk initial phases of geothermal development.

By aligning further investments in geothermal energy with climate change and development objectives, Kenya has accessed funding sources that would have otherwise not been accessible. Carbon finance has recently provided another financing option for geothermal project developers; although with the recent fall of prices for carbon credits in the EU Emissions Trading Scheme, it remains to be seen whether this type of financing can be sustained in the long term.

In Kenya, two geothermal projects have been certified by the Clean Development Mechanism (CDM) and are now contributing over 320,000 tonnes of CO₂ equivalent in avoided greenhouse gas emissions each year.^{13,14} In the Olkaria geothermal plant, existing capacity is increasing, resulting in greenhouse gas emission reductions by displacing fossil fuel-based electricity generation in the Kenyan grid with clean geothermal power. Early stakeholder engagement and benefit-sharing mechanisms with the local communities have been critical to the successful implementation of the project.

Through the Program for Scaling-Up Renewable Energy in Low Income Countries, which is funded through the Strategic Climate Funds, the country has received an allocation of US\$50 million with up to US\$40 million earmarked for geothermal development.

Lessons and implications

Kenya's experience in developing the geothermal energy industry provides a number of lessons for other countries and contexts.

1. Institutional reforms have decentralised key functions within Kenya's energy sector, in order to have the necessary specialist institutions involved.

This suite of institutions includes those which regulate activities (Energy Regulatory Commission), develop favourable policies (Ministry of Energy), generate electricity (KenGen) and carry out exploration and drilling (GDC). All of these functions previously existed, with the exception of the GDC, which has a more specialised mandate.

2. A toolbox of policies and measures are stimulating investment in geothermal:

- Kenya's feed-in tariffs policy is expected to stimulate about 1,300 MW of electricity generation capacity from renewable energy sources, including geothermal. According to UNEP, *"benefits targeted are a 'triple-win' of additional renewables-based generation capacity to the country; enhancing employment and poverty alleviation in the rural areas; and increasing income opportunities for business development"*.¹⁵
- Introducing zero-rated import duty on renewable energy equipment and accessories. This was unusual for Kenya since all goods have an import duty unless explicitly exempted by an Act of Parliament.

- Removing value-added tax (VAT) on renewable energy materials, equipment and accessories. Prior to 2011, there had been a 16% VAT on renewable energy materials.

3. Establishing the GDC as a government body has enabled Kenya to work with international financial institutions and financiers to underwrite risk, secure insurance and secure development partner funding

for the challenging exploration and appraisal phases. It could also receive international support under the Nationally Appropriate Mitigation Actions, which are national programmes established by the United Nations Framework Convention on Climate Change to enable developing countries to access finance for low-carbon development actions that are suited to their national context.

4. Public-private partnerships can be effective if they cover all major project phases.

The public sector focuses on riskier upstream phases, while the private sector partner finances the capital costs in the project construction phase (KenGen is 30% private and 70% government owned).

5. It is paramount to invest in training highly skilled technicians and researchers

because geothermal development requires highly qualified people. KenGen and GDC have partnered with the United Nations University to train geothermal experts. GDC is also establishing a geothermal training centre.

6. Experience in Kenya has shown that engaging stakeholders early is critical to ensure broad support of



the project among communities living in areas where geothermal resources are being developed. Both CDM projects, for example, have ensured that communities are engaged with the projects and benefit from them.

Conclusions

The broad objectives of Kenya's energy policy are to ensure adequate and affordable energy supply to maintain and promote the country's strong economic development and to prioritise the use of low-carbon energy for electricity generation, where feasible. Against a background of challenges, Kenya's electricity sub-sector is making positive strides towards these objectives. By promoting an enabling environment for investment in a widening range of renewable energies and placing a strong focus on geothermal as a response to climate-related constraints and opportunities, the nation is setting out on a low-carbon development pathway.

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The Climate and Development Knowledge Network (CDKN) aims to help decision-makers in developing countries design and deliver climate compatible development. We do this by providing demand-led research and technical assistance, and channelling the best available knowledge on climate change and development to support policy processes at the country level.

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