

# Kenya

## Geothermal Energy Market Overview

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### Abstract:

Kenya is a country endowed with vast geothermal potential located along the world famous East African Rift valley that transects the country from north to south. Kenya's geothermal resources are located within the Rift Valley area. Recent estimates suggest Kenya has geothermal a resource potential of 10 GW spread over 14 sites. Kenya's energy policy of 2004 encourages implementation of indigenous renewable energy sources to enhance the country's electricity supply capacity. Expansion of geothermal power is a major component of Kenya's nationally determined contributions 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. Since serious geothermal exploration first began 50 years ago, geothermal has evolved from a niche technology and resource to a major contributor to the national electricity mix. Geothermal has not only been used for electricity generation but there have also been direct utilisation steps made by Kenya to include recreational purposes, fish farming, heating and fumigation of green houses, milk pasteurization and drying of crop harvests. Various financial partners have played a key role in the development of geothermal resources in the country. Kenya Electricity Generating Company (KenGen) and Geothermal Development Company (GDC), together with the IPPs, aim at raising the country's geothermal output from the current 861 MW to 5 GW by 2030.

### Key Facts

- Installed geothermal capacity 861 MW
- Geothermal about 50% of electricity generation in Kenya
- State-owned KenGen largest operator
- Geothermal resource potential estimated at 10,000 MW
- Kenya ranked no. 9 in Top 10 geothermal countries
- Kenyan specialists supporting wider African geothermal development



## Country Overview

Kenya is a country in Eastern Africa bordered by South Sudan to the northwest, Ethiopia to the north, Somalia to the east, Uganda to the west, Tanzania to the south, and the Indian Ocean to the southeast. The country covers 580,367 square kilometres with a population of more than 47.6 million people according to the 2019 census. Kenya's capital and largest city is Nairobi, while its oldest city and original capital is the coastal city of Mombasa. As of 2020, Kenya is the third largest economy in sub-Saharan Africa after Nigeria and South Africa. The GDP growth (annualised) was 5.7% in Q1 2018, 6.0% in Q2 2018, and 6.2% in Q3 2018.

Kenya is actively engaged in renewable energy resource development with a great focus on geothermal resources because the country is endowed with high temperature geothermal resources. The nation is currently one of the fastest growing geothermal power producers in the world having a total installed capacity of 861 MWe contributing to about 29% of total installed electricity capacity in Kenya, and about 47% of electricity consumed in 2019.

## The Country's Energy Market

The energy sector in Kenya is largely dominated by petroleum and electricity, with wood fuel providing the basic energy needs of the rural communities, urban poor, and the informal sector. Due to the circumstances of fluctuating climatic conditions, the Government of Kenya shifted its focus to the development of more renewable modes of energy generation beginning in the 1970s. The interconnected installed capacity is approximately 3 GWe, of which geothermal contributes about 861 MWe (as of 2020), 837 MWe from hydropower, 807 MWe from thermals, 92.5 MWe from solar, and 336 MWe from wind. Additionally, Kenya has an off-grid installed capacity amounting to 31.1 MWe comprising of 26.3 MWe from thermals, 0.55 MWe from wind, 0.64 MWe from solar, and 3.6 MWe from geothermal. Electricity consumption per capita stands at about 121 kWh. The government is focusing on having 2,500 MWe geothermal contribution in the country's energy mix by 2025.



Source: [ThinkGeoEnergy.com/map](https://thinkgeoenergy.com/map)

## Geothermal resources and potential

Exploration for geothermal resources in Kenya began in 1952. The initial studies were conducted by a consortium of East African Power and Lighting Company Ltd (EAPL), Power Securities Corporations Ltd, Associated Electrical Industries Export Ltd, and Babcock and Wilcox Ltd. The study resulted in the creation of two wells (X1 and X2) in 1956 within Olkaria. The two wells, drilled to a total depth of 950 m and 1200 m, respectively, recorded a measured downhole temperature of about 235°C. Kenya's geothermal resources are hosted within volcanic centers which are located within the axial of the Kenyan Rift Valley. The Kenyan Rift forms part of the larger East Africa Rift System (EARS). EARS transects East and Central Africa, spanning from the Afar triple junction to the North and fading in Beira, Mozambique to the south. Geothermal studies carried out within the Kenyan Rift indicate a potential in excess of 10,000 MW of geothermal resources. The more developed geothermal prospects identified in Kenya include: Olkaria, Menengai, Eburru. The other prospects currently under exploration include: Suswa, Longonot, Arus-Bogoria, Lake Baringo, Korosi, Paka, Lake Magadi, Badlands, Silali, Emurangogolak, Namarunu, and Barrier as shown in the figure.



# Regulatory framework

Kenya has a good energy policy which helps to attract wider energy developers. Before 1998, the development of geothermal resources was solely tasked to a state-owned electricity generation and distribution company - Kenya Power and Lighting Company (KPLC). This considerably slowed down geothermal development. Therefore, the Government undertook a fundamental reform process within the energy sector in 1996. A policy paper on economic reforms set out the government's intentions to separate the regulatory and commercialised functions of the sector to facilitate restructuring and promote private-sector investment. To provide investment security to renewable electricity generators, reduce administrative and transaction costs, and encourage private investors, the Kenyan government published new feed-in-tariffs (FIT) in 2010. The 2010 feed-in-tariff was revised and became effective in 2012 indicating a tariff of 0.0088 USD/kWh for power plants with installed capacity ranging from 35-70 MW. Some of the revisions in the policy include the standardisation of Power Purchase Agreements (PPAs), connecting small

scale renewables, and a change in feed-in-tariff levels. Due to these circumstances, ORMAT International was the first IPP licensed by the Kenya Government to generate 48 MWe from Olkaria III which is situated in the Olkaria Northwest sector in 1997. After successive steps and developments in commissioning power plants, the firm currently operates and sells 155 MWe of electricity to the government. At present, apart from ORMAT, many IPPs are actively engaged in geothermal development for both electricity and direct utilisation in the country. Quantum East Africa Power Ltd, Sosian Geothermal Power Ltd, African Geothermal International Ltd (AGIL), AKIIRA Geothermal Company Ltd, Olsuswa Energy Limited, Arus Energy Ltd, Maralal Energy Ltd, and Capital Power Ltd are among the IPPs.

# Geothermal Energy Utilisation today

Currently, Kenya is ranked ninth in the world for geothermal energy production with an aggregate capacity of about 861 MWe. This power is generated by Olkaria I (45 MWe), Olkaria I unit IV&V (150 MWe), Olkaria II (105 MWe), Olkaria III (155 MWe), Olkaria IV (150 MWe), Wellhead generators (83.3 MWe), Oserian (4 MWe), Menengai (105 MWe), and Eburru wellhead (2.4 MWe). Apart from electricity generation, Kenya uses geothermal for direct utilisation purposes at Olkaria, Menengai and Eburru fields. Some of the direct utilisation steps made by Kenya include recreational purposes, fish farming, heating and fumigation of green houses, milk pasteurization and drying of crop harvests. The first recorded direct use application in Kenya was the pyrethrum dryer built in 1939 in Eburru for use in drying pyrethrum flowers and grains. The drier is supplied with geothermal water from a well at 95°C adjacent to the drying chamber at about 43°C. The community pays per weight of materials to be dried as they co-share the maintenance of the facility. The Eburru area is water scarce and potable water mainly comes from condensed steam from fumaroles and a well drilled using old techniques of water recovery for that purpose. It is reported that up to 6,000L/day is recovered from the condensers. Oserian Development Company in Naivasha owns



KEY GEOTHERMAL SITES IN KENYA Source: GDC





and operates the world’s largest geothermally heated greenhouse growing rose flowers. The geothermally heated greenhouse project at Oserian covers 50 hectares where around 185 TJ/yr of energy is used. The project uses hot water from a well (OW-101) leased from KenGen. At Menengai, GDC developed a pilot direct use facility - geothermally heated water from well MW-03 at 90°C is cascaded through laundry, milk pasteurizer, aquaculture, and finally a greenhouse after which the water is recirculated. Furthermore, a large-scale commercial bathing spa has been developed by KenGen at Olkaria II geothermal field. The spa utilises separated brine meant for reinjection in the field. Three hot water pools/lagoons receive hot brine sequentially from the source depending on the desired pool temperature. The brine flows into the first lagoon at around 95°C, and then flows into the second lagoon at around 85°C, and finally into the third lagoon at around 69°C. The main and largest lagoon is maintained at temperature of 35°C. KenGen has also created a sauna and steam bath running on brine. The other use of geothermal resources for hot bathing is located at the Lake Bogoria hotel where shallow hot wells are used to provide hot water for the swimming pool.

and one Wind power plant producing 26 MW, for a combined generating capacity of 1,803 MW. Presently, KenGen operates seven geothermal power stations: Olkaria I, Olkaria II, Olkaria I unit 4 and 5, Olkaria IV, Olaria I Auxiliary Unit, Olkaria V, Eburru, and a site referred to as Wellhead.

In 2009 the Kenyan government formed the Geothermal Development Company (GDC) (through an act of parliament in 2008) as a special purpose vehicle (SPV) intended to undertake surface exploration, as well as exploratory, appraisal and production drilling before handing them over to KenGen or other private developers.

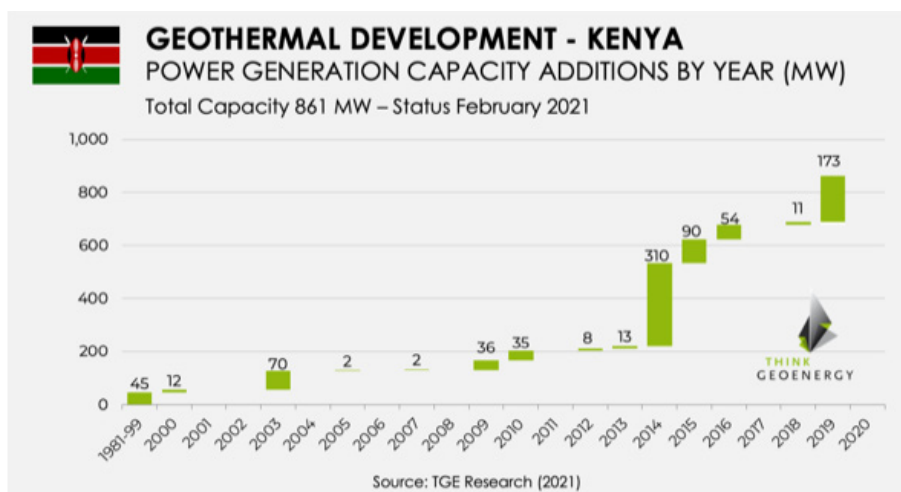
IPPs are actively engaged in geothermal development activities by contacting different prospects.

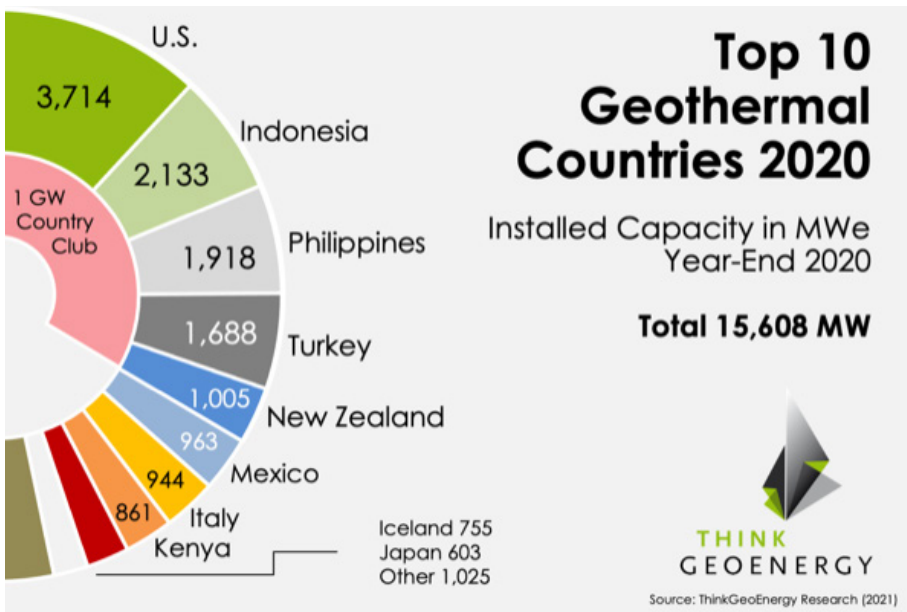
Donor and loan agencies such as the World Bank, JICA, EIB, KfW, AU through GRMF facility, as well as China EXIM Bank are among the key financiers in drilling operations and power plant construction activities in Kenya.

Following a long delay in the development of three geothermal power plants under an IPP model following the drilling by state-owned GDC, there seems to now be a change in strategy. Instead of seeking private developers to take on the development of the power plants, it is now seems like KenGen are taking over the development of power plants in the further stages of geothermal development at Menengai. Strategy change re: GDC ... on the IPP vs drilling, direct use

## Geothermal Market & Industry

As geothermal increases in popularity in Kenya, apart from the public entities (KenGEN and GDC), both IPPs and financiers have greater plans for the geothermal ground. KenGen was formed through an act of parliament enacted in 1996. It was established in 1997 and its mandate was to generate electricity. KenGen relies on various sources to generate electricity ranging from hydropower, geothermal, thermal, and wind. The company owns 30 hydropower plants with a combined capacity of 818 MW, four thermal power plants generating 256 MW, eight geothermal power plants with a generating capacity of 706 MW,





## Outlook

The Kenyan government has planned for an installed generation of 5,000 MW by the year 2030. To achieve this target, more than 1,000 trained personnel will be required. Skills development for the staff will be undertaken through training in international institutions and, to a larger extent, training at the newly established Africa Geothermal Centre of Excellence that is based in Kenya - a shared ownership with multiple African countries. The additional capacity of about 4,000 MWe will come from expansion of Olkaria and Eburru geothermal fields by KenGen and IPPs, as well as additional installations at Menengai by GDC. GDC is currently undertaking exploration drilling in the Baringo-Silali geothermal prospect with a plan of generating some hundreds of MWe. The first exploration well drilled in Paka was successful. However, the flow test results are awaited to confirm the well capacity. Additional generation is planned to come from IPPs that have been licensed various geothermal prospects.

## Current Project Development

KenGen is currently continuing its ongoing development with Olkaria I Unit 6 geothermal plant set to be finalised in 2021, which will add an additional 83 MW in capacity. There are continued efforts on geothermal wellhead power plant generation and private development efforts (e.g. for the three IPP projects at Menengai).

KenGen continues to work internationally providing drilling services - e.g. in Ethiopia and Djibouti.

Efforts on direct use development continue with GDC at Menengai, as well as with industrial park ambitions at Lake Naivasha both by KenGen and private company, Oserian Flowers.

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