



# Geothermal Consultancy and Drilling Services



**KenGen**  
Energy for the nation.



## **About KenGen**

Kenya Electricity Generating Company PLC (KenGen) is the leading power generating company in Kenya, producing about 75% of electricity consumed in the country.

It is a limited liability company registered under the Companies Act (Cap 486) of the Laws of Kenya.

The company uses various sources to generate electricity ranging from hydro, thermal, wind and geothermal.





# **KenGen Geothermal Expertise and Capability**



Over the years, from 1950's, KenGen has developed a wealth of expertise in geothermal resource exploration and development through hands-on experience, training and career development of staff. The Company also promotes research, technology and innovation in geothermal energy.

The Company has an affiliation with other geothermal and geoscientific/engineering players regionally and internationally in order to keep in tandem with latest technological developments in the geothermal industry. KenGen has joint partnerships with the University of Twente in Netherlands for capacity building in geomatics engineering, United Nations University in Iceland for capacity building in geothermal technology and Jomo Kenya University of Technology and Dedan Kimathi University in Kenya on renewable energy technologies and research.

Our staff are exposed and trained globally in top universities and institutions in USA, New Zealand, Japan, South Korea, Australia, Iceland and Dubai on drilling, reservoir modelling and management, geoscientific works, environmental and sustainability and geothermal power plant operations and maintenance.

Further, KenGen is a corporate member of the African Rift Geothermal Project (ARGeo) and also a member of International Geothermal Association (IGA), Geothermal

Resource Council (GRC), Geothermal Association of Kenya (GAK) and Geological Society of Kenya (GSK). KenGen is a key sponsor of the United Nations University (UNU) Geothermal Training Programme (GTP) that is held annually in Kenya since its inception in 2006.

KenGen has well established expertise in; Geology, Geochemistry, Geophysics, Geomatics/GIS, Civil and Infrastructure Engineering, Environmental Management and Stakeholder and Community Engagement, Drilling Operations and Services, Reservoir and Steam field management, as well as, Power plants installation and operation.

The Geology team is well experienced and skilled in geothermal surface exploration, well siting and well design methodologies, borehole geology, geothermal mineralogical studies including petrography, fluid inclusion and XRD analytics. Geochemistry team has expertise in geochemical exploration in geothermal prospects, fluid chemistry, chemical analysis of alteration hydrothermal deposits and environmental chemistry monitoring. The team is also experienced in monitoring power plant chemistry.

Geophysics team has expertise in geothermal exploration surveys using Magneto Telluric (MT), Transient Electro-Magnetic (TEM), and gravity, seismic and magnetic techniques. The team is also active in monitoring of geothermal







exploitation using gravity and seismic techniques to monitor for subsidence associated with abstraction or related to fluid re-injection.

KenGen Reservoir and Steam field Team is responsible for carrying out scientific assessment such as heat loss surveys and geothermal reservoir size estimation, numerical and conceptual modelling and simulation. Also, key responsibility and expertise of this team is well measurements and tests necessary for evaluating geothermal reservoir characteristics of a field and also management of the steam field infrastructure.

The Company has invested and acquired the required tools and equipment for the tasks which include temperature and pressure tools, calibration machines for the instruments, truck mounted logging units, winches, truck mounted cranes, recovery tubes, test separators, and pressure monitoring tools.

The team also carries out deviation surveys and Static Formation Temperature Tests (SFTT) and completion tests after drilling. It has expertise in interference tests, discharge tests, and design of re-injection schemes. Besides managing reservoir and steam-fields of Olkaria and Eburru wells, the team has also offered consultancy services to external

customers such as Oserian, Orpower4 and Akiira Geothermal Companies in carrying out well completion and discharge tests of its drilled wells.

Coherently, the teams have developed a proprietary well siting and well design methodologies that they have continued to improve and perfect over the years. The teams have also provided consulting services in geothermal exploration several African countries including Rwanda, Djibouti, Zambia, Comoros and Sudan.

KenGen has qualified and experienced staff on Environmental and Social Impact Assessment (ESIA) studies for geothermal related projects, Resettlement Action Plan (RAP) implementation, ISO quality audits, Strategic Environmental Assessments (SEA), Environmental and Social Management Plans (ESMP) implementation and stakeholder and community engagement.

The Company has a fully-fledged department that deals with environmental, safety, quality and social issues related to geothermal development. The department comprise of a multi-disciplinary team of Scientists and Engineers. Members are registered with National Environment Management Authority (NEMA) either as Lead or Associate EIA/Audit Experts.



The civil and infrastructure team has expertise in design and construction of access roads, design and construction of well pads, design and laying of water lines for drilling water supply. They support the geoscientific and environment teams during fieldwork. After exploration wells have been sited for drilling, the team makes all necessary infrastructural preparations that includes access roads, water pipelines and well pads.

KenGen has adequate state-of-the-art equipment, software and laboratory facilities for implementation of geothermal resource exploration, development and management. This is coupled with well trained and experienced staff and has been key towards geothermal development in Kenya, as well as, consulting for other institutions in the region. All disciplines are well supported by qualified and experienced GIS/Geomatics expertise in engineering and cadastral survey, topographical mapping, GIS and Remote sensing, geospatial data acquisition, analysis, processing, interpretation and presentation.



## GEO-SCIENTIFIC STUDIES

*Resistivity Data Collection using MT Equipment*



## **GEOPHYSICS SERVICES**

The company undertakes geophysical investigations for geothermal resources including various surface-based exploration surveys for prospects delineation, reservoir assessments, and field management. The company has modern geophysical equipment, which include a Transient Electromagnetic (TEM) instrument that has a high resolution for investigating conductivity structure of the top 1,000 metres of subsurface, and Magneto-Telluric (MT) equipment that is capable of collecting high resolution resistivity data upto 10,000 metres deep

The services offered include: -

- Geothermal exploration surveys using TEM, MT, Gravity, Magnetism, Microseismics, DC-Schlumberger
- Monitoring of subsidence using gravity method
- Microseismic survey for dams and dam sites, foundations, and volcanic monitoring
- Sediment thickness assessment in dams and lakes using seismics
- Microseismic monitoring of geothermal fields under exploitation

## **GEOCHEMISTRY SERVICES**

The Company has a modern Geochemistry Laboratory in Olkaria equipped with modern analytical machines. They include an automatic Atomic Absorption Spectrophotometer coupled with graphite furnace; a modern Gas Chromatograph; an ion Chromatograph; and double beam UV - VIS Spectrophotometer; ICP Mass Spectrophotometer; among other bench analysis equipment.

Our team of highly qualified geochemists carries out geothermal exploration surveys to determine possible indications of geothermal resource. This is done by sampling hydrothermal fluids and determining radon and CO<sub>2</sub> counts.

The services include: -

- Geochemical exploration in new prospects
- Chemical analyses of liquid and gas samples
- Geothermal reservoir assessment
- Tracer tests design and implementation
- Production field monitoring



### ***Fumeroles Sampling for geo-hazard monitoring***

The laboratory also carries out discharge sampling, test, analysis and interpretation of drilling returns. The quality of steam entering power plants is routinely collected at the drain pots of the moisture separators and analyzed for TDS, CL, and pH.





*Geochemical data analysis*





*Resistivity Data Collection using MT Equipment*

## **GEOLOGY SERVICES**

KenGen offers surface exploration surveys, geothermal well logging, design and monitoring of drilling operations, development of geological models, and strategies for field development and management. The company has a well-equipped Geology laboratory with lapidary equipment for the preparation of thin and thick sections for petrographic and fluid inclusion studies respectively.











A computerized Siemens D5000 Diffractometer (XRD) is routinely used for analyzing oriented clay and mineral separates. The results from XRD data help in the evaluation of geothermal reservoir conditions including temperature, chemistry and permeability.

The services include: -

- Field mapping
- Well logging and drilling management
- Preparation of thin and polished rock sections
- Petrographic analysis
- Fluid inclusion studies
- XRD analysis and interpretation of clay and mineral water
- Geotechnical investigations



# GEOTHERMAL DRILLING SERVICES

KenGen owns and operates 3 drilling rigs complete with all the auxiliary equipment: two electric land rigs with capacity to drill wells up to a depth of 7,000 metres and a National (N370) drilling rig that can drill wells up to 2,200 metres. KenGen employs innovative drilling techniques and tools that minimize cost and duration of drilling wells. Some of the innovations realized in our drilling operations include directional drilling, manufacture of drilling detergent and use of PDC drilling bits. Over the years, the company's staff have garnered considerable experience in drilling geothermal wells having successfully drilled over 300 wells in the region.

The company offers the following services: -

- Geomatics and information management
- Preparation of well pads
- Geothermal well design and drilling supervision
- Drilling of geothermal wells
- Design and construction of drilling water supply system
- Design and construction of discharge brine disposal systems and fluid re-circulation ponds
- Design and construction of access roads
- Overhaul of heavy diesel engines and water pumps





# RESERVOIR ENGINEERING





Through continuous research and collaboration with partners including universities, development partners and other government agencies, KenGen has developed expertise necessary for evaluating geothermal reservoir characteristics of a field and managing the steamfield infrastructure. The company has invested in requisite tools and equipment including temperature and pressure measurement tools, calibration machines, truck mounted logging units, winches, truck mounted crane, recovery tubes and test separators.

We are capable of offering the following services: -

- All aspects of well tests including deviation surveys, SFTT, completion tests, discharge tests, shut-in tests, down-hole pressure and temperature surveys, and interference tests.
- Reservoir assessments for new fields
- Re-injection scheme design, pipeline design, production field monitoring and management
- Simulation studies for predicting field life and effects of cold/ hot re-injection



*Geothermal reservoir data collection*

# POWER PLANTS OPERATIONS AND MAINTENANCE

KenGen owns four geothermal power stations, Olkaria I, Olkaria II, Olkaria IV and Olkaria I unit 4 & 5. In addition to the Power stations, KenGen own fifteen wellheads generation plants in Olkaria and Eburru. The Geothermal Power Plants have a combined generation capacity of 533.5MW.

## **Olkaria I Power Station**

Olkaria I Power Station was the first geothermal power plant in Africa. The 45 MW plant was commissioned in three phases and has three units each generating 15MW of electricity. The first unit was commissioned in June 1981, the second and third units in November 1982 and March 1985, respectively. To date, a total of 33 wells have been drilled for the station. The plant has had an average availability factor of over 95% since commissioning. The power generated is connected to the national grid via a 132KV-transmission line.

## **Olkaria II Power Station**

Located in the North Eastern sector of the greater Olkaria Geothermal field and commissioned in 2003, Olkaria II Power

Station generates 105 MW. Initially, the power plant generated 70 MW from two units of 35 MW each. Later, a third 35 MW unit was added. Construction of the third unit commenced in 2009 and was completed in May 2010. The power generated is transmitted to the national grid via 220 kv double circuit line.

## **Olkaria I Unit 4 & 5 And Olkaria IV Power Station**

Olkaria IV and Olkaria I unit 4 & 5 each generating 140 MW were commissioned in December 2014 and February 2015 respectively. This is the country's largest Geothermal Power Project. The projects were funded by KenGen and bilateral partners such as World Bank, Japan International Cooperation Agency (JICA), European Investment Agency (EIB), Africa Development Bank and KfW.

## **Wellhead Generation Plants**

The Company has installed fifteen wellhead generating units with a capacity of 83.5MW in Olkaria and Eburru geothermal fields. A pilot wellhead generating unit was commissioned in February 2012.



*Olkaria I Power Station*



***Olkaria Wellhead Pilot Plant***





Leveraging on the experience and expertise in successfully operating geothermal power plants for many years, KenGen is capable of offering the following services: -

- Installation and commissioning of electric motor driven pumps; cooling tower facilities, and electrical installations
- Coupling and alignment of turbines and generators
- Maintenance and plant management of geothermal steam field facilities
- Mechanical plant and instrumentation including turbine inspection and overhaul
- Maintenance of air compressors and pneumatic systems
- Maintenance of electrical plant and protection systems
- Generator tests and stator rewinding, transformer tests and oil regeneration.
- Cooling towers- Structure- member corrosion monitoring and maintenance
- Mechanical workshop services- machining, welding, and sheet metal works

# GEOTHERMAL DRILLING AND CONSULTANCY PROJECTS

KenGen is in a consortium with Shandong Kerui Petroleum Equipment Company Limited and Shandong Kerui Oilfield Service Company Limited was awarded a contract by the Ethiopian Electric Power (EEP) for the Supply of drilling rigs and its accessories as well as rig operation and maintenance for drilling geothermal wells at Aluto, Langano in Ethiopia. Other projects include the following: -

- Well tests measurements for OrPower4, Inc, an Independent Power Producer
- Geoscientific Investigations of the Kapisya and Chinyunyu Geothermal Fields, Zambia
- Geophysical investigations in Djibouti
- Geoscientific Investigations in the Comoros
- Geoscientific Investigations in Rwanda
- Geoscientific Investigations in Lake Magadi area (for Magadi Soda Company)



- Geoscientific Investigations in Sudan (Northern)
- Drilling services and water supply for AKIIRA an Independent Power Producer
- Onsite Geological Consultation and Mud Logging in Djibouti- with Iceland GeoSurvey (ISOR)
- Reconnaissance survey in the Comoros in 2008
- Seismic Refraction and multichannel analysis of surface waves (MASW) surveys for Sogea Satom Company
- Hydrogeological survey for ground water mapping and assessment in wajir county using geophysical methods.
- Geoscientific services to GDC, Ministry of Energy, Oserian
- Topographical survey in Uganda
- Geoscientific studies in Rwanda- with Iceland GeoSurvey (ISOR)
- Geoscientific studies in Uganda- through Geothermal Drilling Systems International
- Geoscientific studies in Mbeya region of Tanzania through Geothermal Drilling Systems International
- Resistivity work in Yemen
- Detailed geoscientific study of Barrier Volcanic Complex (BVC- use of the techniques of geology, geophysics and geochemistry to develop a geothermal conceptual model of Barrier Volcanic Complex for siting target wells for drilling

## RESEARCH & COLLABORATION

KenGen cooperates with national and international institutions in carrying out important research on various aspects of geothermal development. Some of the areas of cooperation have included: -

### 1. **Geothermal exploration**

Refining geothermal exploration via geochemical modeling of young volcanic centers in the Kenya Rift. The research was done in collaboration with the University of Texas at El Paso, USA and funded by NSF.

### 2. **Geothermal Reservoir Management**

Use of stable isotopes in geothermal reservoir management in Africa, Latin America and Asia. Funded by IAEA.

### 3. **Joint Geophysical Imaging (JGI)**

Research into the use of combined MT, TEM and seismology in refining the exploration for geothermal reservoirs. Project was funded by UNEP/ GEF and implemented in collaboration with Duke University, USA.

### 4. **Hydrogeology of the Lake Naivasha area**

A cooperative venture between KenGen, the Lake Naivasha Riparian Association and ITC, Netherlands in research on the hydrology of the Lake Naivasha basin.

## 5. ARGeo Project

KenGen is a member of the African Rift Geothermal Project (ARGEO), which is funded by UNEP/ GEF with the aim of promoting the development of geothermal resources in Africa.

## 6. Other areas of Collaboration

Other areas of research and collaboration currently being pursued include:

- a. Assessment of suitability of Bentonite deposits in Meru and Isiolo as geothermal wells drilling mud.
- b. Use of brine for geothermal well cementing.
- c. Conversion of power station blowdown into portable water.
- d. Use of geothermal brine for rehabilitation.
- e. Use of geothermal brine for fish farming.
- f. Use of brine for horticulture.
- g. Use of geothermal steam for cooling.
- h. Modification of silencers.
- i. Design of Improved Well Testing Facility and Commercial Heat Exchanger- Grant of about 9 million from National Council of Science and Technology.
- j. Increasing Efficiency in the Utilization of Brine to run a Binary Power Plant.
- k. Pre-cast Pre-stressed Concrete Pavement (PPCP).
- l. Use of Modern Survey Techniques in Optimization of Geothermal Power Harvest.
- m. Real Time Relaying of Geothermal Information and Data Directly from the Field to Computer Server using GSM and GPRS Technologies of Mobile Mapping and GIS.
- n. Improvement of Cooling Towers in Olkaria I.
- o. Investigating the Possibility of Harnessing Gravitational Energy using an Actuating Lever Arm Mechanism.
- p. Designing & Fabrication of Aluminium Sheet Rolling Machine and Aluminum Ridge Making Machine.
- q. Sustainability of Lake Naivasha.
- r. Well Testing Facility, Commercial Heat Exchanger, Gas abatement
- s. Remote management of water levels in tanks at Olkaria
- t. Assessment of cooling circuit water to control acid erosion, elemental sulphur deposition and microbiological fouling: Case study of Olkaria II
- u. Precipitation chemistry and air quality monitoring associated with geothermal operations





## CERTIFICATION

ISO 9001:2015 Certification (Quality Management system)

ISO 14001: 2015 Certification (Environmental Management System)





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