

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT SUMMARY

MENENGAI GEO-THERMAL POWER PROJECT - GDC

Project Name: MENENGAI GEOTHERMAL POWER PROJECT

Country: KENYA

Project Number: P-KE-FZ0-003

1. Introduction

This ESIA summary is for the Menengai Geothermal Power Project. The project is verified as category 1 in terms of AfDB's ESAP. The Bank's role is to provide a loan of UAC 80 million. The project proponent is the Geothermal Development Company Limited (GDC). GDC is a 100% government owned State Corporation operating under the Ministry of Energy. It was created as a special purpose company to accelerate the development of geothermal resources in Kenya. Its core activities include exploration, drilling, assessing and development of geothermal resources for power generation and other alternative uses. Prior to the establishment of GDC, the government of Kenya undertook surface scientific geothermal studies in Menengai area. Kenya's power industry generation and transmission system planning is undertaken on the basis of a 20 year rolling Least Cost Power Development Plan (LCPDP) updated every year. According to the latest LCPDP, the country has an installed electricity generation capacity of 1,424 MW and a reliable capacity of 1,397MW under average hydrological conditions. The unsuppressed peak demand stands at 1,146MW. This leaves no reserve margin to allow for reduced hydro generation as is being experienced currently due to droughts and plant breakdowns. Geothermal power generation has a potential estimated at around 7,000 MW, is the choice of the Government of Kenya (GoK) for the future. The Menengai field alone (prospects have demonstrated that it is the best site for Kenya) could potentially produce up to 1,650 MW of power. It is against this background that the GoK officially requested the Bank on March 23rd 2011 to consider financing this Project, which involves the development of the Menengai geothermal field for up to 200 MW power as a first phase. For the remaining potential of 1450 MW in the Menengai site, GDC is discussing with the Chinese and Japan Bank for International Cooperation (JBIC) for possible financing in the tune of US\$ 166 and 200 million respectively.

2. Project Description and Justification

The project involves civil works for construction of access roads, drill sites and drilling and testing of 3 exploration, 6 appraisal, and 27 production geothermal wells to exploit geothermal energy. Well testing activities include down hole, completion and other scientific tests. The exact number of production wells will be determined by the average output of each well. The wells will be drilled to economical depths of approximately 3000 m to access geothermal fluids (steam and water). Two operational rigs for Menengai geothermal drilling project will require 1,200,000 m³ for every 60 days of drilling. Wanyororo spring has a yield of 35 m³/hr, which means the shortfall will be covered by about 5 boreholes with a yield of 12 m³/hr each. Four tanks will be required to store 8,000 m³ of water for supporting the 2-rig operation. The Project is structured as a Public Private Partnership (PPP). Geothermal field

development will be financed by the Government of Kenya and its development partners, which includes the Bank.

Following geothermal development there are other aspects of the project such as power plant construction and this will be financed by a private investor. Evacuation of power from power plant will be through a transmission line. Detailed study for the evacuation of power from Menengai will be undertaken by Kenya Electricity Transmission Company Ltd (KETRACO) once the other two phases have progressed significantly. The ultimate objective of the Project is to meet the rapidly increasing demand for power in Kenya by developing the country's huge geothermal potential. The necessity of this project is shown by the fact that it has already commenced showing need and urgency to provide power to Kenya after drought reduced Kenya's hydropower capacity. The portion of the project to be financed by the Bank aims at developing the Menengai geothermal steam field for 200 MW power generation.

3. Policy, Legal and Administrative Framework

The project proponent is expected to comply with some relevant national and international requirements. The principal national law in this case is the Environmental Management and Coordination Act (EMCA) of 1999 and the Environmental (Impact Assessment and Audit) Regulations of 2003. Other national legislations relevant to the project are identified below.

GDC operations and implementation of projects will be guided by its corporate Health, Safety and Environment Policy. The EHS policy is a 91 page document with procedures for all likely injuries, alcohol drugs and weapons; adverse weather conditions; fire prevention; security issues, emergency preparedness in terms of drills with varying frequencies, e.g. monthly for fire and annually for incidents such as earthquakes. The policy also includes formations of safety committees and their operation; the use of all forms of PPE, fall protection in terms of ladders, working at elevated heights; it includes environmental aspects such as incidents regarding steam, waste, uncontrolled air emissions, peak noise emissions etc. The policy has been presented to top management and has not yet been approved because of the recommendation to add management of landslides. GDC Geology and Geophysics section is currently performing geodetic studies through commissioned Deformation Monitoring and Micro-seismic monitoring stations around the Caldera. The findings of which will be used to advise the project on landslide/subsidence and will be included in the EHS policy. The company is committed to establishing, implementing and maintaining a sound environmental management system to ensure that its activities are environmentally acceptable and sustainable. This will be achieved by putting in place a voluntary ISO 14001 management system.

Other Acts of Parliament that work together to regulate and guide geothermal and natural resource use in a sustainable manner hence relevant to this project include

- Geothermal Resources Act of 1982 and supplementary legislation of 1990 and the Second Schedule of EMCA of 1999.
- The Electric Power Act Cap 48
- The Forest Act Cap 385,
- The Water Act Cap 372,
- The Water Act (2002) Part VI Section 94,
- The Factories & Other Places of Work (Noise Prevention & Control Rules) Act 2005 (*Cap. 514*),
- The Wildlife Conservation and Management Act.

- The Environmental Management (Air Quality) Regulations (2008),
- The Occupational Safety and Health Act (2007),
- The Environmental Management (Solid Waste) Regulations (2006),
- The Environmental Management (Water Quality) Regulations (2006),
- The Environmental (Impact Assessment and Audit) Regulations (2003),
- The Agricultural Act,
- The Public Health Act (Cap 242 Revised Edition 1986),
- The Chief’s Authority Act (Cap 128 Revised Edition 1998),
- The Local Government Act (Cap 265 Revised Edition 1998) & Regulations (1966): Section 145,
- The Penal Code (Cap 63 Revised Edition 1985),
- The Petroleum Bill (2002),
- The Foods, Drugs and Chemical Substances Act (Cap 254 Revised Edition 1992),
- The Use of Poisonous Substances Act (Cap 247 Revised Edition 1983),
- The Radiation Protection Act (Cap 243 Revised Edition 1985),
- The Irrigation Act Cap 374,
- The Fisheries Act No 5 of 1989,
- The Lakes and Rivers Act Cap 409,
- The Land Planning Act Cap 303,
- The River Authorities Act Cap 443,
- The Way Leaves Act Cap 292,
- The Antiquities and Monuments Act Cap 215
- The Workmen’s Compensation Act (Cap 236 Revised Edition 1988) Part II.

Besides the legislation, there are international guidelines that govern the development of geothermal resources and Kenya is also a signatory to a number of international treaties and conventions. Those that are relevant to the proposed Menengai geothermal drilling project include:

- The **United Nations Framework Convention on Climate Change (UNFCCC)**, which has established an ultimate objective of stabilizing GHG emissions at a level that would prevent anthropogenic interference with global climate.
- The **1994 Convention for Biological Diversity**, whose objective is conservation of biological diversity, the sustainable use of its components and fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

The project also requires certain permits and licenses and they include:

Legislation/Other requirement	Licenses and/or Permits
Geothermal Resources Act of 1982 and supplementary legislation of 1990	Geothermal resource exploration license
EMCA, 1999	EIA license
The Factories and Other Places of Work (Noise Prevention and Control Rules) Act 2005 (<i>Cap.514</i>)	Noise emission license
Environmental Management (Water Quality) Regulation, 2006	Effluent discharge license
Environmental Management (Solid Waste) Regulation, 2006	- Waste disposal site license - License to generate hazardous waste
Electric Power Act Electricity	Generation license
Environmental Management (Air Quality) Regulations, 2008	Emission discharge license
The Water Act (2002) Part VI Section 94	Water abstraction permit

The ESIA and EMMP (approved on 4 March 2009 and transferred from KenGen to GDC on 22 February 2010) were compiled in accordance with the Environmental Management and Coordination Act (EMCA) of 1999 and the Environmental (Impact Assessment and Audit) Regulations of 2003. The ESIA license was deemed adequate to cover all the other licenses listed above. However, recently many pieces of legislation have been passed to include individual license. GDC is now in the process of acquiring all these other licenses. For Geothermal Licensing; a letter of Authority from the Minister of Energy for geothermal exploration and development was obtained.

The Bank's policies and procedures that are relevant include: Environmental Policy (2004), Policy on Poverty Reduction (2004), Policy on Population (2002), Gender Policy (2001), Policy on Disclosure of information (2005), Policy on Good Governance, Policy on Public Consultation and Cooperation with Civil Society (2001), and African Development Bank Environmental and Social Assessment Procedure (2001).

4. Description of the Project Environment

Environmental Matters

4.1 Physiography

Menengai caldera is a major physiographic feature in the rift floor and is also important for its geothermal potential. The caldera floor, which is fairly flat, covers an area of about 88 km² and is partially covered by young rugged lava flows. The topography is made up of flat grounds.

4.2 Hydrogeology and surface drainage systems

The surface drainage system is largely from the east and the western scarps. On the rift floor, the drainage is mainly from Menengai Caldera northwards with the exception of the drainage from the southern rim or slopes of Menengai Caldera into Lake Nakuru. The permanent rivers in the area are Molo and Rongai in the NW area. The perennial rivers are the Crater and Olbanita streams in the eastern parts. The N-S, NE-SW, and NW-SW trending fault/fracture systems provide underground channels resulting to stream water disappearing underground at some places interrupting the Olbanita stream at several places. Other surface water bodies include Lakes Nakuru and Solai, and the Olbanita swamp. The area is swampy and dominated by dry and thermally anomalous boreholes. The swamp owes its existence to impervious bedrocks that have been affected by hydrothermal alteration. Productive boreholes in the area are characterized by very shallow, low-yield aquifers that get depleted fast since the deeper formations are impervious. It is also worth noting that the Wanyororo spring is seasonal and the community never depended on it solely. In the long run, the spring and the boreholes will increase water availability for the community.

4.3 Geology and soils

The surface of Menengai project area is covered by volcanic rocks mostly erupted from volcanic centres that can be categorised into exposed older lava flows, flat grounds that are covered by derivatives of plinian eruptions with few interrupting scarps and the Menengai volcano. The soil profiles of these areas are shallow, stony and saline.

4.4 Meteorology

The project area is classified into two main agro-climatic zones. The lowland areas of Mogotio and Kisanana in the north are located in semi-arid zone IV with an annual rainfall of

800 mm and mean temperatures of 30°C. Njoro, Bahati and parts of Kampi ya Moto divisions with an altitude of between 1800 m and 2400 m above sea level and average rainfall of between 760 mm and 1270 mm per year fall within a dry sub-humid equatorial climatic zone. Around Nakuru area, mean annual rainfall is approximately 900 mm. The rainfall regimes are bimodal with the long rains occurring in March to July and the short rains in September to November. Temperatures vary with topography and range from 9.4 to 29.3 °C.

4.5 Air quality and noise

There is no information on air quality background levels with the exception of H₂S which was measured at 0 ppm, but looking at activities in the area, dust would be the only challenge from time to time. The project will result in air pollution from Non Condensable Gaseous (NCG) emissions, exhaust smoke from generators, compressors and vehicles. The most important NCG is hydrogen sulphide gas due to its unpleasant odour and toxicological effects. H₂S ground level concentrations are expected to be about 1.0 ppm during drilling, which is far below the WHO threshold human exposure limit value of 10 ppm. The risk of Hydrogen Sulphide gas will be managed through a monitoring network of monitoring stations determined through air dispersion modelling, taking into account the location of emissions sources and areas of community use and habitation. The monitoring system will be used for early detection and warning. Emergency planning involving community and employees will be established. These mitigation measures will form part of the ESMP.

Noise background levels at receptor sites were measured at around 25 dB(A) to about 50 dB(A), additional noise emissions can arise from actual drilling and well testing operations. Drilling and testing emissions levels would range from 80 – 90 dB(A). The ESMP will entail mitigation against noise pollution and this will include; noise measurement; education, training and awareness raising; engineering noise control; provision and use of PPE; periodic hearing tests for employees; and the Drilling Manager, Reservoir Manager and the Procurement Manager shall ensure that the machines installed in the rig sites, camps and wells are appropriately designed or have built-in noise reduction devices, which ensure the lowest possible emission and in any case not exceeding ninety dB(A).

4.6 Biodiversity

Menengai Forest is at an altitude of 9910 ft above sea level with total gazetted area of 7,315.3 ha including the crater. The forest vegetation resembles that of the “true savanna”. Cedar is currently being illegally harvested and this has affected its survival in the caldera. *Erytherina abyssinica* used to be wide spread within the forest but has been decimated by herbalists who use it for medicinal purposes, thus could become endangered if not controlled. There are very few wild animal species due to unavailability of open grazing and dispersal areas. Leopards, Baboons, Wild pigs and Snakes are common within Menengai Caldera. Cases of Human - Wildlife conflicts mainly due to invasions of farms by the Baboons and Monkeys have been reported.

4.7 Climate Change

The project is a clean energy project with no significant and direct impact on climate change. However, that does not protect the project against climate change effects and in this case the infrastructure will be designed such that it can withstand likely natural disasters and accidents. The project may have indirect impacts on climate change because the source of energy for some people in the area is firewood and the project would provide access to the forests in the caldera. However there is controlled access to the area.

5. Socio Economic Matters:

5.1 Land ownership and use

About 60% of the land in the proposed project area is public owned land comprising of the Menengai Forest which covers the Northern, Eastern and Southern parts of the Menengai Caldera. The rest of the land is privately owned with average farm sizes of 4-5 hectares. The local population in the northern and north-eastern parts of the project area employ the land for small-scale intensive mixed farming, including keeping livestock. The eastern and southern parts of the project area consist of suburban and urban developments. The local population in the western part of the project area and in parts of the Caldera floor engages in large-scale wheat and dairy farming.

5.2 Water sources for domestic and livestock consumption

Wanyororo Spring and the Crater Stream (Kandutura) serve as the primary sources for water for domestic and livestock consumption in the project area. Boreholes and surface runoffs supplement these water sources. With the exception of the elevated concentration of Pb and F in the Wanyororo spring water, other chemical parameters are within the NEMA domestic water source quality criteria. The water may be used for both drilling and domestic consumption after appropriate treatment.

5.3 Transport and communication

The area is well serviced by a network of earth roads and all weather roads. Main users of the roads are matatus' (public transport vans), private cars and cyclists. The existing roads network, railway lines, electric power service lines, telecommunication lines and GSM coverage of the prospect area is adequate and will not need any upgrading. Existing roads entering the Caldera had to be widened and new roads in the Caldera had to be constructed.

5.4 Energy sources and consumption

The main sources of energy for cooking and lighting in the project area are kerosene and wood fuel. Most of the charcoal is obtained by the local population from the Menengai Caldera and the Menengai Forest. The inaccessibility of the proposed project area is a major threat to the forestry resource close to the project area as the Kenya Forestry Service (KFS) has been hindered to conduct effective security patrol to curb charcoal burning. The closest electricity power supply line is on the edge of the caldera approximately 2 km to the proposed water borehole drill sites off Ahero Market Centre through the Gingalili Farm.

5.5 Education

The proposed project area has few private and public pre-primary, primary, secondary, tertiary and adult education facilities. Most of the education facilities are located within Nakuru Municipality. Nakuru municipality has 60 primary schools with a total enrolment of 47,937 pupils (Municipal Council of Nakuru, Education Department December 2007).

5.6 Employment

The area has a literacy rate of 71% but most of the labour force in the proposed project area is unskilled. The main employers in the project area are the commercial sisal, coffee, wheat and other agricultural farms and industries located in Nakuru Municipality. Males dominate especially the commercial and industrial sectors. Building stone quarrying, ballast crushing and sand harvesting are also common activities. The project will create 912 skilled and about 300 unskilled jobs

5.7 Public health and sanitation profile

Rift Valley Provincial Hospital is the largest health facility in the project area located in Nakuru Town. There are also a number of health centres and dispensaries within the project area. According to the District Public Health Office (Ministry of Health, Nakuru), the top ten most common diseases in the project area for listed health facilities are malaria, upper respiratory tract infections, skin diseases, diarrhoea, accidents, rheumatism, pneumonia, eye infections, urinary tract infection and dental disorders. In terms of sanitation, apart from Nakuru town that has the municipal sewage system. Most of the stakeholders in the project area mostly use soak pits, septic tanks and pit latrines. Latrine coverage for the project area has been estimated to be 68.6%.

5.8 Tourism

The Menengai caldera, and Lake Nakuru National Park are among other areas with a major tourist attraction potential in Nakuru District. The caldera peak offers a panoramic view of the surrounding areas including Nakuru Town. Lake Nakuru, a Ramsar site, located a few km south of the Caldera is famous for being the first successful Rhino Sanctuary in Kenya and habitat for flamingoes. There is potential to package Lake Nakuru National Park together with Menengai caldera and Lord Egerton Fort as tourist attraction sites under an ecotourism project. Menengai caldera is already attracting many local and foreign non-paying visitors.

5.9 Agriculture and food insecurity

The main agricultural activities (both commercial and subsistence scale) of the project area are livestock keeping and crop farming. In the areas surrounding Menengai Caldera and parts of the intra-caldera, the main cash crops are wheat, sisal and coffee while the main food crops are maize, beans and potatoes. In the Kiamunyi, Mashiari, Menengai farm, Valley farm and Kampi ya Moto areas, large-scale wheat, maize and dairy farming are predominant. In the eastern side of the caldera rim, subsistence farming of maize, beans, potatoes and horticultural crops (tomatoes) is dominant. Large-scale sisal and coffee farming and livestock keeping characterize the Banita and Solai areas. The Bahati area is mainly characterized by small-scale maize, beans, potatoes, horticultural crops (tomatoes and pyrethrum) and dairy farming. Livestock keeping is also practiced within the caldera particularly in accessible areas located to the west. Horticultural crop production is carried out in the municipality and Rongai division.

Food insecurity exists within the project area due to various circumstances. Food shortages in Rongai division are brought on by poor weather conditions. In Nakuru municipality, food insecure groups consist of families living on the streets and in slum areas, many of which suffered from the 2007 post-election violence. Relief food has been granted by the Kenyan Government and from international donors. In addition, food prices are increasing while production quantities are reducing. This poses a significant problem for those who are not necessarily displaced but rely on local markets.

5.10 Archaeological and historical sites

Hyrax Pre-historic Site is the only site of historical significance within the prospect area and is of immense significance to Kenya's archeological research development efforts over the decades. It is located on Hyrax Hill, which owes its name to the numerous hyraxes that used to live in the rocky openings. The archaeological features dating between 200 and 5000 years ago have been found on the foot of the hill. Together with other sites in the region, it has formed a basis of understanding of evolution of mankind from hunting and gathering way of

life to a greater dependence on food production especially pastoral activity in these high grasslands.

5.11 Local community cultures, core values and heritage

There are no distinct cultures and values that can be associated with the local communities that inhabit the project area and its surroundings. The area is cosmopolitan and comprise of people from different ethnic communities.

6. Project Alternatives

6.1 Alternatives to the site:

The proponent has leased 20 ha of land from KFS for the proposed development. There could be alternative sites within the Menengai caldera where the project could be implemented. The proposed sites are however good based on the geothermal resource location scientific studies and prevailing environmental parameters.

6.2 Alternatives to Technology & Their Analysis

Alternatives	Activities	Advantages	Disadvantages
The no project option	alludes to the possibility that there is no geothermal exploration and operation.	The negative impacts, during both construction and operation phase, including vegetation clearance, risks of pollution during construction, would not become reality.	<ul style="list-style-type: none"> ◆ Thus the country would continue to rely on hydro power which has already proved its unreliability in the past few years of drought ◆ Positive impacts expected from the clean energy will also not be realised
The Menengai Geothermal Drilling Project (Proposed project)	<ul style="list-style-type: none"> ◆ Drilling of geothermal wells to supply steam for proposed 140 MWe power station 	<ul style="list-style-type: none"> ◆ Expansion in geothermal resource harnessing in line with the national energy policy ◆ Resource potential ascertained. ◆ US\$ 72 million for drilling of wells guaranteed. ◆ Large part of resource area situated in public land ◆ Less overall activity impact since the resource is situated within the Menengai Caldera floor. ◆ Less labour force (64 persons, 32 people per shift working 5 shifts on 2 rigs). ◆ Less investment in infrastructural development in-terms of communication and labour camps ◆ No relocation of neighbouring communities. ◆ Reduction of CO2 emissions. 	<ul style="list-style-type: none"> ◆ High cost of exploratory geothermal drilling.
The Olkaria Domes Appraisal Drilling Project ◆	<ul style="list-style-type: none"> ◆ Drilling of six appraisal & 22 production wells and about 22 production wells. 	<ul style="list-style-type: none"> ◆ The project implementation in progress. ◆ US\$ 12 million for drilling appraisal wells secured. ◆ Expansion in geothermal resource 	Location of the project in the proximity of a conservation and recreational area.

Alternatives	Activities	Advantages	Disadvantages
	<ul style="list-style-type: none"> ◆ Upgrading of access roads 	<p>harnessing in line with the national energy policy</p> <ul style="list-style-type: none"> ◆ Resource potential ascertained. ◆ Less labour force (52 persons, 13 people per shift working for 4 shifts day and night) ◆ Less investment in infrastructural development in-terms of housing and communication and overall activity impact. ◆ No relocation of people. 	
The Olkaria II 3rd Unit Extension Project	Construction of 35 MWe Olkaria II Unit 3 within the existing Olkaria II power plant.	<ul style="list-style-type: none"> ◆ The project implementation in progress. ◆ US\$ 50 million for 3rd Unit extension secured. ◆ The Olkaria I power plant has an installed capacity of 45MWe. However, following the connection of wells OW-32 and OW-34, the steam available currently stands at an equivalent of about 70 MWe, a surplus of 35 MWe. ◆ The new units of Olkaria II have a better specific steam capacity of 7.8 Kg/kWh than those at Olkaria I at 9.2 Kg/kWh and therefore generate the power using less steam than originally envisaged. ◆ The available surplus steam in Olkaria II is 28 MWe ◆ The total estimated steam surplus between the two plants is therefore about 53 MWe, out of which 35 MWe will be developed. ◆ Reliable and operated at base load. ◆ Reduction of CO2 emissions 	<ul style="list-style-type: none"> ◆ Additional civil works connecting Olkaria I and II
The Eburru Early Generation Geothermal Power Project	<ul style="list-style-type: none"> ◆ Construction of 2 MWe Eburru Geothermal Power Plant 	<ul style="list-style-type: none"> ◆ Short project implementation schedule (12 months) capable of fast tracking geothermal resource harnessing which is in line with the national energy policy ◆ Resource availability ascertained. ◆ US\$ 4 million for power plant construction. ◆ Less labour force (less than 100 persons during peak construction period) ◆ No investment in infrastructural development in-terms of access roads, housing and communication and overall activity impact. ◆ No relocation of neighbouring communities ◆ Reliable and operated at base load ◆ Reduction of CO2 emissions 	<ul style="list-style-type: none"> ◆ Location of the project in the proximity of a gazetted indigenous Eburru forest which is part of the eastern boundary of the Mau Escarpment forming part of the Mau Narok Forest system
Raising of Masinga Dam alone.	<ul style="list-style-type: none"> ◆ Raising impervious core of the main dam to 1060.5 and concrete 	<ul style="list-style-type: none"> ◆ Increase incremental energy average of the Masinga and downstream cascade stations by about 50GWh/year ◆ Increase in head will improve turbine 	<ul style="list-style-type: none"> ◆ Some 1.8 GWh/year will be lost by Tana Power station. ◆ Raising of the dam

Alternatives	Activities	Advantages	Disadvantages
	wave wall installed ♦ Modification of the service spillway by constructing labyrinth type of spillway crest at EL 1058.0 ♦ Raising of emergency spill way crest ♦ Upgrading of toe drains and some instrumentation	efficiency ♦ Incremental output generated from Tana cascade due to raising of Masinga Dam is expected to displace slow or medium diesel speed generation ♦ Minimal environmental impacts ♦ Less capital intensive. Construction costs at approximately US\$ 8 million ♦ Short implementation time of about 12 months ♦ EIRR of 22.8% with EIRR falling to 17.7% in worst case scenario (15% rise in capital cost and 15% fall in energy benefit)	will pose additional maintenance risks associated with sealing of draft tube gates and leaking of stuffing boxes at the Tana power station ♦ Machines on the downstream stations of the cascade will have to operate for longer periods at higher loads. This will mean strict adherence to scheduled maintenance and overhauls.
Raising of Masinga Dam & Redevelopment of Tana Power Station	♦ This involves raising of Masinga dam and redevelopment of Tana Power Station as under one contract	♦ Raising of Masinga dam & reconstruction of a new power station with an installed capacity of 23.4 MWe with an annual average energy output of 172 GWh/year ♦ Reduced O&M costs	♦ Cost implications. ♦ More civil works
Redevelopment of Mini-hydro Stations upstream of Masinga Dam	♦ This involves redevelopment of small mini hydros constructed before independence ♦ There are:., Mesco, Ndula, Wanjii, Sagana Tana I and Tana II	♦ Increase in energy output ♦ Reduction in current operation and maintenance costs	♦ Capital intensive ♦ More costly than raising of Masinga dam ♦ Minor Resettlement ♦ Longer implementation period
The Construction of Mutonga & Low Grandfalls downstream of the cascade	♦ This involves construction of two dams Mutonga (60 MWe) and Low Grandfalls (140 MWe) downstream of Kiambere reservoir on the Tana or Construction of Mutonga alone	♦ Capacity expansion by 200 MWe ♦ Annual average energy (715 GWh/y for Low Grandfalls and 337GWh/year for Mutonga ♦ Minimization of downstream floods ♦ Internal rate of return is 13.8%	♦ Capital intensive, US\$ 550.2 million for both Low Grandfalls and Mutonga as of June 1997 without price escalation or US \$ 187.7 for Mutonga alone option ♦ Longer construction period of about 12 years ♦ High environmental impact e.g. resettlement and downstream impacts
The Combined Cycle Diesel Power Plant	♦ This involves procurement and installation of Diesel Generating Units.	♦ Shorter construction period and material ♦ Less capital investment	♦ High Operations and Maintenance costs. ♦ Escalating fuel costs ♦ Fuel transportation costs ♦ Environmental Pollution

7. Potential Impacts and Mitigation/Enhancement Measures

There will be both positive and negative social and environmental impacts emanating from the project.

7.1 Positive Impacts of the Project:

During exploratory drilling, the workforce will stimulate local businesses within urban centres of the affected project area even though this will be a temporary impact. Unskilled positions will be given to the locals hence uplifting the livelihood of the local community both temporarily and for longer term. Direct and indirect employment opportunities, involving skilled and unskilled labour, will translate into additional incomes for the concerned households. In addition, the employment opportunities created by the project will result in the injection of additional resources into the local, regional, and national economies.

The upgrading of the access roads will improve access to Menegai caldera for security operation and tourism purposes. Construction, operation and maintenance of the access roads to the project area will have a long-term positive impact. The upgrading of the access roads will improve access to caldera for security operation and tourism purposes. The proposed project is within Menengai caldera, which is a tourist attraction noted particularly for its scenic beauty; moreover, geothermal development in itself is a tourist attraction feature and this creates opportunity to enhance the touristic nature of the area. In the long term, the project is anticipated to contribute an additional 140 MWe to the national grid, thus leading to reduction in the use of fossil fuels. The development is a clean energy project with ample capacity creating many national and regional opportunities.

7.2 Negative Impacts of the Project:

Social Impacts:

Social impacts will include temporary change in population due to influx of people in search of employment. During drilling and well testing, there could be increased dust, noise and air pollution levels. There will be some increase in vehicular movement to the project area through the access roads and this could result in elevated dust level as the road are not tarred and some increased noise levels. Drilling operations always present an element of danger. Occupational health and safety of the workforce will have to be monitored by the respective Contractors' supervisors and Foremen. An Environment, Health, and Safety Officer will be on site to ensure compliance to relevant regulations by the Contractor. For all identified social impacts, the proponent has developed an EMMP designed to thoroughly mitigate these negative social risks.

None of the land on the project site is inhabited by any person. Land access rights, specifically for water boreholes and access roads, are being sought for landowners whose parcels will be required for the project. KenGen's property office has surveyed the parcels and has initiated compensation negotiations with owners of affected land parcels. Compensation will be based on market property rates agreed upon by each landowner and KenGen. The proposed geothermal wells drill sites are located on the public land (Menengai Forest) and negotiations are underway between KenGen and the Kenyan Government, through the Kenya Forest Service who are the custodians of Menengai forest. No crop cultivation occurs on the proposed project site (inside Menengai caldera), and thus there will be no acquisition of farmland. Measures for addressing the impacts associated with land access rights are covered in the ESMP.

Environmental impacts:

Clearing and levelling of sites using heavy machinery may interfere with ecological niches for the few resident species in the area leading to habitat loss. Disturbance of the plant community may induce changes in species composition. Clearance of vegetation will expose the soil to wind and water erosion. Drilling fluids may result in the contamination of water and soil. Drilling and well testing also result in the generation of H₂S and other non-condensable gases (NCG) and this will be in addition to exhaust gases (CO₂, CO, NO_x, SO_x, Particulate Matter) and dust from machineries during mobilization and by traffic movement during drilling.

Summary of Mitigation to be employed for the negative social and environmental impacts:

Once drilling has been done, restoration of the worked area should be carried out immediately to deal with negative and temporary visual impacts. Further visual impacts due to the infrastructure will be lessened by the fact the project site is in a depression unless viewed from vantage points. Moreover, use of equipment with neutral, non-reflective colours that blend with the natural vegetation would reduce the visual impacts of the drilling facilities. The impact of increased dust, noise and air pollution levels will be lessened by the fact the most near settlement is approximately 400m away from the proposed project sites and noisy equipment will be equipped with silencers. The risks posed by the drilling and operation would be decreased by adhering to procedures entailed in the EHS policy and using adequate personal protective equipment (PPE) as per the occupational, health and safety policy

Employees are constantly sensitized through awareness and training to ensure protection of flora and fauna in the Caldera. The updated ESMP will also include mitigation for use of caldera forests as fire wood. The equipment is designed to withstand climate change impacts such as floods; drought, etc. To mitigate against negative social impacts there are other issues that will have to be dealt with in the ESMP to ensure their implementation; these include; monitoring and scheduling of community issues such as supply of water and electricity to the local community, freedom of passage for grazing purposes, employment for locals in terms of actual numbers and commitment and for other issues such education through CSR scholarships, long term project benefits to the community.

8. Environmental Hazard Management

Technological hazards identified for the project include landslides and tremors. These hazards will be addressed through measures highlighted in GDC's Health, Safety and Environment Policy.

9. Monitoring Program

The project's monitoring program and associated responsibility are addressed through the Environmental Management and Monitoring Plan developed by GDC. The ESMP includes specific measures for minimizing and addressing the project's environmental and social impacts. A total budget of 139,000,000 Kenyan Shillings has been allocated in order to effectively implement the ESMP. GDC's Environment, Safety and Community Liaison Department will be responsible for implementing the ESMP and preparing progress reports for submission to the Bank. About 100 acres of uninhabited land has been identified for acquisition from 22 private land owners who will be compensated each at a cost of Kshs 250,000 per acre. The cost of the land is included in the ESMP costs.

10. Public Consultations and Public Disclosure

The purpose of public participation was to sensitise interested and affected parties and to gather their concerns with an intention to cater for the communities because the ultimate objective of the project with regard to local communities is to ensure that they are not worse off as a result of the project. The consultation process identified relevant stakeholders as the Bahati, Kiamaina, Wanyororo, Kabatini, Engoshura, Solai, Banita, Mashiaro, Menengai Hill, Valley Farm, Kiamunyi/Olive, Ol Rongai & Kwa Gitau communities. Four public consultation meetings were held in these communities between 17 March and 4 April 2008 during the preparation of the ESIA.

Key priorities raised by stakeholders included building of access roads; providing electricity and water to the area residents; freedom of passage for grazing purposes; employment for the local population; afforestation (tree nursery establishment); addressing the human-wildlife conflict; land ownership and compensation for affected parcels; enhancing security in the project area; enhancing education through corporate social responsibility scholarships and long term project benefits to the community. Key concerns raised by stakeholders centred on land compensation for affected parcels, geological risks, qualification requirements for casual/ unskilled jobs, air quality issues, effects on tourism, industrial accidents and fire outbreaks, the safety and health of the residents from the associated impacts, threats of earth quakes and faulting, the management of gas emissions, the location of the drill sites, and the importation of labour. The design, implementation, and monitoring features of the project have been developed to integrate the concerns, priorities, and perspectives raised by stakeholders during the consultation process.

11. Complimentary Initiatives

The project does not involve any involuntary resettlement. Conscious of the environmental and socio-economic circumstances in the project area, GDC has developed complimentary initiatives as a means of making positive contributions to uplifting the project area, its surrounding communities, and the environment. GDC's holistic Corporate Social Responsibility approach emphasizes community investments. As such, GDC intends to assist local communities through the development of Community Action Plans and financing various projects, such as the formation of cooperatives. The municipality will be empowered in that GDC will hand over the current potable water system to the community (municipality). GDC plans to use geothermal resources it extracts to promote initiatives of socio-economic significance to surrounding communities. Through the provision of steam and water generated during its main activities, GDC will seek to promote, among others activities, aloe vera farming, watermelon farming, pyrethrum farming, fish farming, improved pasture land, milk processing, afforestation, grain storage, and tourism. GDC is in the process of finalizing a Memorandum of Understanding with the Kenya Forest Services with respect to collaborating on environmental conservation, safety, security, and land management matters. Finally, GDC plans to establish a Regional Geothermal Training Institute to build capacities of interested professionals nationally and regionally.

12. Conclusion

In conclusion an ESIA process and the associated reports satisfy the applicable national legislations and relevant requirements applicable to the environmental and social safeguards policies and procedures of the Bank. It is therefore evident that while there may be some negative impacts emanating from the project, the overall benefits outweigh them. Mitigation put in place to address the negative impacts will be improved to include all other impacts

identified in the ESIA and the improved EMMP (ESMP) will be approved by the Bank prior to tabling this project to the Board.

It is therefore recommended that the loan conditions and covenants for this project make explicit requirements for strict implementation and compliance to the recommended and approved ESMP which shall form part of the contractors' contract and furthermore the ESMP will have to include management of compliance with other requirements and recommendations by the national government authorities through their various permits and licenses.

13. References and Contacts

- i. African Development Bank's Public & Private Sector Operations 2001, Environmental and Social Assessment Procedure.
- ii. Final EIA Report and EMMP: Phase 1 - Augment Supply from Mokolo Dam August 2010 by NEMAI consulting.

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