

ENVIRONMENTAL, SOCIAL AND SAFETY ASPECTS ASSOCIATED WITH IMPLEMENTATION OF GEOTHERMAL POWER PROJECTS: THE CASE OF 280MW GEOTHERMAL POWER PROJECTS AT OLKARIA IN NAIVASHA SUB-COUNTY, KENYA.

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Abstract

Geothermal power plants have a vital role to play in realization of Kenyas' Vision 2030 in the context of a green economy. This is because geothermal energy is clean and renewable. Implementation of geothermal power plants has the potential of resulting to environmental, social and safety aspects. These aspects contribute to both positive and negative impacts. Environmental and Social Impact Assessment (ESIA) is a tool that enables organizations to anticipate, manage and respond to environmental, social and safety aspects. The management actions arising from ESIA are clearly defined and translated into an Environmental Management Plan (EMP) for the construction, operation and/or decommissioning phases of a project. If properly done, the ESIA provides an opportunity for building trust with the workers, local community, regulatory authorities and other key stakeholders. As a result, organizations are increasingly finding that the tool adds value to business process and reduce business risk in the long run.

However, often ESIA tend to be based on preliminary planning which doesn't necessarily give an indication of, for example, the approach to construction. A clear understanding of the management challenges for the construction phase often only develops once the detailed design has been completed. In order to promote effective environmental management, there is need to update the EMP during the detailed design and planning phase, and as part of the bidding and sub-contracting process for the construction phase.

The Kenya Electricity Generating Company Limited (KenGen) is developing power plants to generate 280MW of electricity at Olkaria in Naivasha Sub-County, Nakuru County, Kenya. The power plants, designated as Olkaria IV and Olkaria I unit 4 and 5, are located 10Km apart and will each have an installed capacity of 140MW. Olkaria I unit 4 & 5 power plant is located within Hell's Gate National Park.

ESIA studies for the 280MW Olkaria I unit 4 & 5 and Olkaria IV geothermal power projects were carried out separately in 2009 at the preliminary planning stage. As a result, the ESIA studies failed to provide all the envisaged environmental, social and safety aspects associated with the construction phase of the projects. This paper aims at filling this gap and highlighting the best practices in the construction of the project through hands-on experience. The findings will provide an insight into the actual impacts of geothermal projects located in a sensitive ecological area such as Olkaria hence assisting in the identification of adequate mitigation measures for the future projects.

1. INTRODUCTION

Geothermal power plants have a vital role to play in realization of Kenyas' Vision 2030 in the context of a green economy. This is because geothermal energy is clean and renewable. Nevertheless, like any infrastructure development, geothermal power has its own environmental impacts and risks that have to be assessed, mitigated, and managed. The need for a careful assessment and mitigation of all significant impacts from a geothermal power project is often underscored by a plant's location in an environmentally sensitive area, which is not unusual for greenfield geothermal development. However, the impacts from a geothermal power project are usually highly localized and site specific and few, if any, of them are irreversible (ESMAP, 2012). In most cases, mitigation measures can be readily designed and implemented. Environmental Impact Assessment (EIA) is a legislated tool used to assess the positive and negative environmental impacts of a proposed project and its alternative options; and to propose measures to mitigate its potential negative impacts and enhance the positive Impacts (DEAT, 2004a).

In Kenya, EIA and Social Impact Assessment (SIA) are often undertaken at the same time, defining the "environment" and "environmental impacts" broadly to include social and cultural aspects of development hence the name Environmental and Social Impact Assessment (ESIA). EIA process in Kenya is summarized in Figure 1 below.

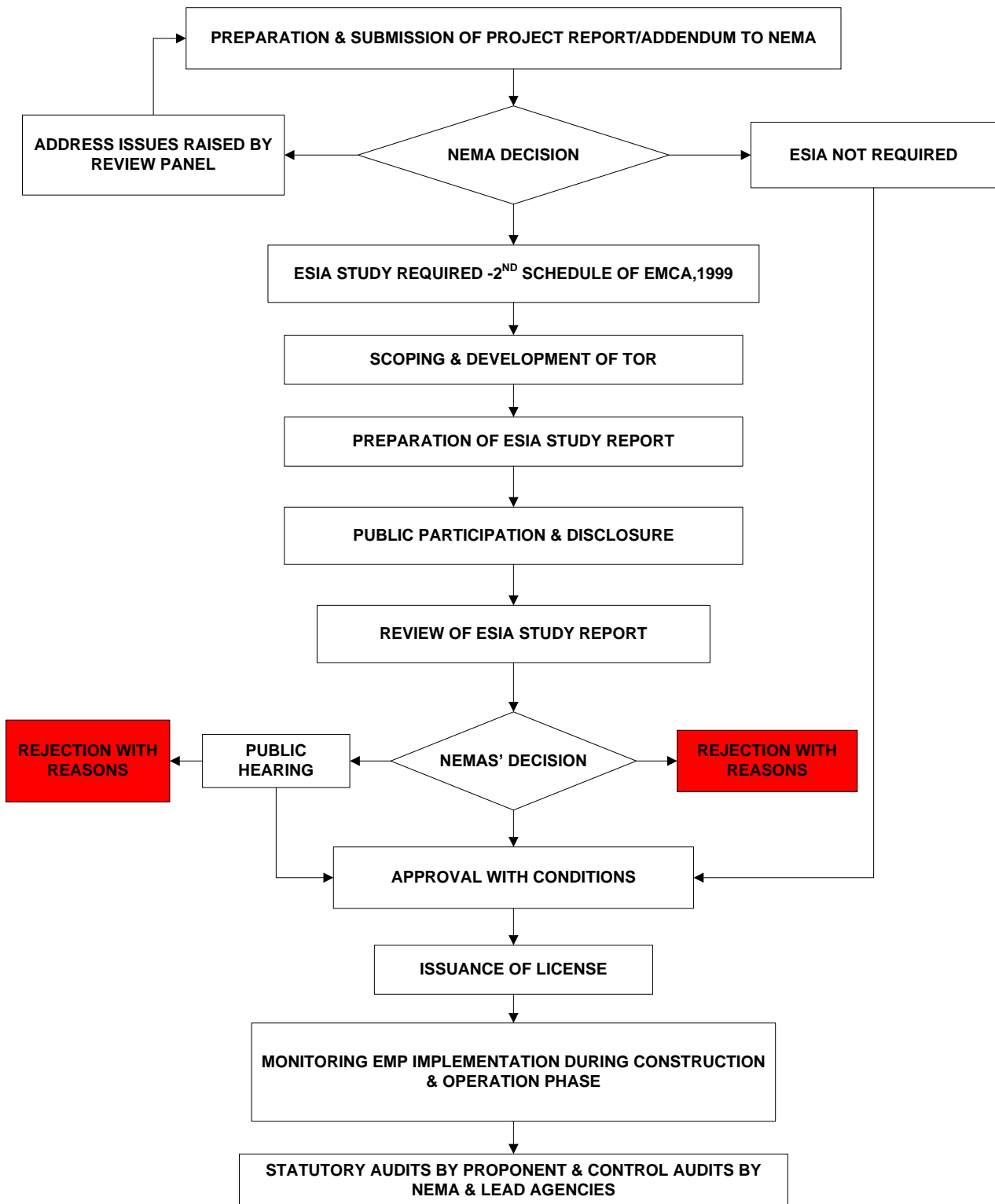


Figure 1: EIA Process in Kenya (Barasa P.J, 2014)

An EIA for a large scale project should take into consideration direct or indirect effects on the following (UNEP, 2008):

- i. public health,
- ii. abiotic and biotic environment and
- iii. Socio-economic and cultural environment:

KenGen integrates the assessment of social impacts and benefits into EIAs to produce Environmental and Social Impact Assessment (ESIAs). This integration enables the company to anticipate, manage and respond to environmental, social, health and safety aspects inclusively.

EIA identifies potential problems and opportunities associated with a project and is thus an essential part of the project cycle (Economic Commission for Africa, 2005). In so doing, EIA contributes to the transparency of the decision-making process during the development, implementation, monitoring and follow-up stages of a proposed project (UNEP, 2002). Therefore, if EIA is properly designed and coordinated, it can be an effective tool for achieving sustainability. However, in order to promote effective environmental management throughout the life-cycle of a project, it is important that the management actions arising from EIAs are clearly defined and translated into an Environmental Management Plan (EMP) for the design, construction, operation and/or decommissioning phases of a project (Lochner, 2005). In view of the importance of EIA follow-up after obtaining approval, many countries have legislated for, or have put in place, procedures to guide the implementation of the EMP or conditions of the permit and for monitoring compliance with these conditions (Economic Commission for Africa, 2005).

EIA has little value unless follow-up is carried out because without it the process remains incomplete and the consequences of EIA planning and decision-making will be unknown (Morrison-Saunders et al, 2007). An Environmental Monitoring Committee or Environmental Liaison Committee may be established to monitor progress in the implementation of the EMP, and can provide a forum for stakeholder engagement. The committee has an advisory, monitoring and “watch-dog” role that can extend for the duration of the construction or operational phase of the project (DEAT 2004b). This approach is usually reserved for large-scale projects, like the proposed 280MW geothermal power projects at Olkaria, and provides an opportunity for regular dialogue. Stakeholders need to understand that their safety, health and environment are not being compromised. They should be kept informed so that no uncertainty exists in this regard. Such participation, and the flow of information generated through this process, can also encourage local stakeholders to take a greater degree of responsibility for their environment and welfare in relation to the project, and to feel empowered that they can do something practical to address issues that affect their lives (IFC, 2007). Participatory monitoring also tends to strengthen relationships between the project and its stakeholders. An example of how communication channels and responsibilities can be structured to facilitate implementation of a construction phase EMP is shown in figure 2 below.

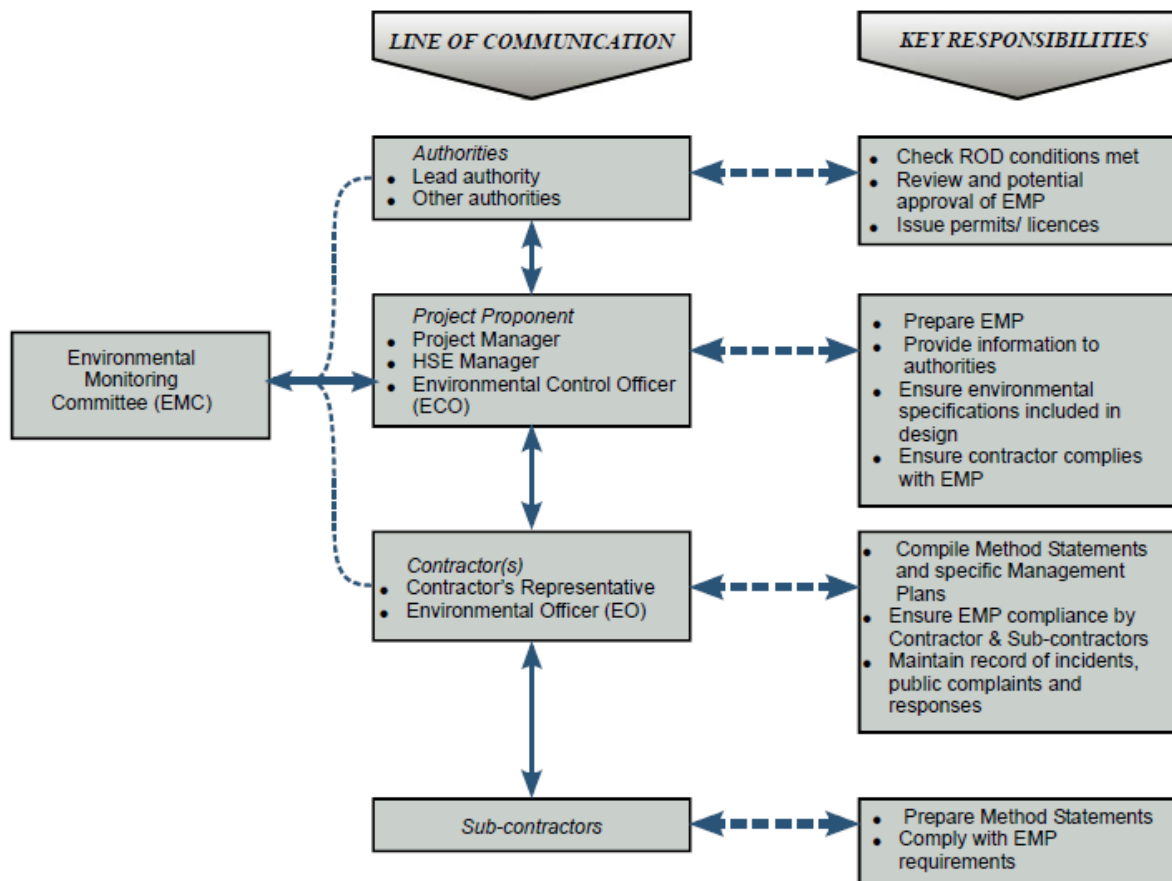


Figure 2: An Example of how Communication Channels and Responsibilities can be Structured for Construction Phase EMP (Lochner, 2005)

The shortcoming of many EIAs is that they tend to be based on preliminary planning which doesn't necessarily give an indication of, for example, the approach to construction. A clear understanding of the management challenges for the construction phase often only develops once the detailed design has been completed (Lochner, 2005). It is against this background that this paper has been prepared to provide an insight into the actual impacts of geothermal projects located in a sensitive ecological area such as Olkaria

hence assisting in the identification of adequate mitigation measures for the future projects. The paper also seeks to highlight some of the best practices adopted during the project construction phase.

2. LEGAL INSTRUMENTS FOR EIA IN KENYA

EIAs usually take place within the distinctive legislative frameworks established by individual countries and/or international agencies. In Kenya, the requirement for undertaking EIA is governed by the following legislations.

2.1 Environmental Management and Coordination Act, 1999

The requirement for conducting EIA is provided for by section 58 of the act. This section states partly that notwithstanding any approval, permit or licence granted under the Act or any other law in force in Kenya, any person, being a proponent of a project, shall, before financing, commencing, proceeding with, carried out, executing or conducting or causing to be financed, commenced, proceeded with, carried out, executed or conducted by another person any undertaking specified in the Second Schedule to the Act, submit a project report to the Authority, in the prescribed form, giving the prescribed information for the purpose of applying for an EIA license.

Section 68 of EMCA, 1999 provides the need for EIA follow-up as highlighted below.

68. (1) The Authority shall be responsible for carrying out environmental audit of all activities that are likely to have significant effect on the environment. An environmental inspector appointed under this Act may enter any land or premises for the purposes of determining how far the activities carried out on that land or premises conform with the statements made in the Environmental Impact Assessment study report issued in respect of that land or those premises under section 58(2).

(2) The owner of the premises or the operator of a project for which an EIA study report has been made shall keep accurate records and make annual reports to the Authority describing how far the project conforms in operation with the statements made in the EIA study report submitted under section 58(2).

(3) The owner of premises or the operator of a project shall take all reasonable measures to mitigate any undesirable effects not contemplated in the EIA study report submitted under section 58(2) and shall prepare and submit an environmental audit report on those measures to the Authority annually or as the Authority may, in writing, require.

2.2 Environmental (Impact Assessment and Audit) Regulations, 2003

Regulation 16 spells out the key requirements for an EIA. According to this regulation, an EIA study for a proposed project shall take into account environmental, social, cultural, economic, and legal considerations, and shall –

(a) identify the anticipated environmental impacts of the project and the scale of the impacts;

(b) identify and analyze alternatives to the proposed project;

(c) propose mitigation measures to be taken during and after the implementation of the project; and

(d) develop an environmental management plan with mechanisms for monitoring and evaluating the compliance and environmental performance which shall include the cost of mitigation measures and the time frame of implementing the measures.

Regulation 34 provides the need for EIA follow-up after obtaining approval from NEMA. It states that in executing a project, after the EIA study report has been approved by the Authority, or after the initial audit of an ongoing project, the proponent shall take all practical measures to ensure the implementation of the EMP by –

(a) carrying out a self-auditing study on a regular basis;

(b) preparing an environmental audit report after each audit and submitting the report to the Authority annually or as may be prescribed by the Authority; and

(c) ensuring that the criteria used for the audit is based on the environmental management plan developed during the environmental impact assessment process or after the initial audit.

3. DESCRIPTION OF THE PROPOSED PROJECTS

3.1 Project Components and Financing

KenGen currently owns and operates two Geothermal Power Stations namely Olkaria I and Olkaria II. The two power plants have a capacity of 45MW and 105MW respectively. The company is in the process of constructing two additional geothermal power plants namely Olkaria IV and Olkaria I unit 4 & 5 in line with its ambitious strategy of increasing geothermal power generation capacity by 1,110MW by 2020. Each of these power plants has a capacity of 140MW. The power plants will comprise of a power house complete with turbines, generators, control room, workshop & other auxiliaries. Steam gathering system, brine re-injection system, production and re-injection wells, service roads, a substation and transmission lines will also be provided. Construction of the two power plants is at an advanced stage and commissioning is expected to take place by December 2014. The main project contractor is Hyundai Engineering Co. Ltd whereas the project consultant is Sinclair Knight Merz Ltd (SKM).

The two projects are co-financed by the World Bank (IDA), Japan International Cooperation Agency (JICA), European Investment Bank (EIB), KfW Development Bank (KfW) and Agence Francaise de Development (AFD).

3.2 Project Location

Olkaria geothermal field is located within Hells' Gate location in Naivasha Sub-county, Nakuru County. KenGens' geothermal licensed area measures 204 KM² and is one of the prospects located along the Kenyan Rift Valley as shown in figure 3 below. Part of the concession area lies within Hell's Gate National Park which measures approximately 68.25KM². Olkaria geothermal field neighbours Lake Naivasha, which is a Ramsar site, flower farms and some villages inhabited by an indigenous community (the Maasais).

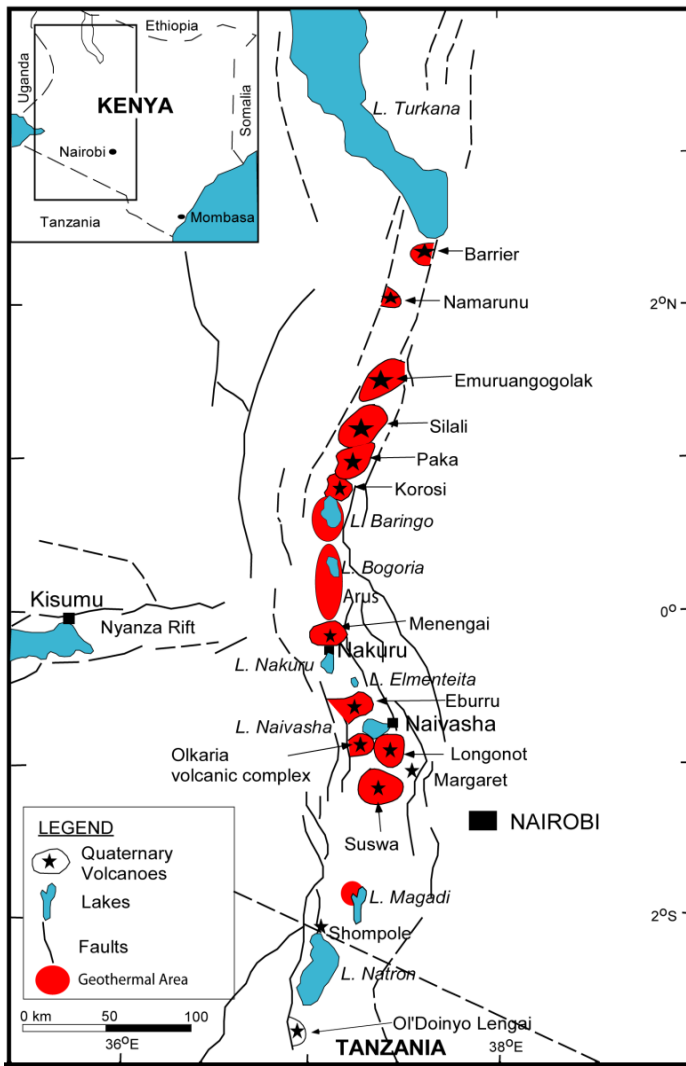


Figure 3: Map Showing Location of Olkaria Geothermal Project

3.3 Land Requirements and Acquisition

KenGen estimated that a total of 1461 hectares (3610 acres) of land was needed for putting up the power plants and associated infrastructure. The findings of the air quality and noise dispersion modeling carried out during ESIA studies indicated that approximately 600 acres of land adjacent to the power plants was going to be impacted negatively. Therefore the total land that was required for the power plants was 4210 acres. Out of these, a total of 35 hectares (86.48 acres) comprised of four villages inhabited by the Maasai community. Acquisition of this land necessitated involuntary resettlement of the local community.

4. ENVIRONMENTAL, SOCIAL AND SAFETY ASPECTS

4.1 Involuntary Resettlement

Separate ESIA studies for Olkaria IV and Olkaria 1 Unit 4 & 5 Power Plants were carried out in 2009 by KenGens' appointed consultant, GIBB Africa Ltd. The findings of the studies indicated that the local community living on and in the vicinity of the land identified for the establishment of the proposed power plants was to be impacted negatively by the cumulative effect of noise and Hydrogen Sulphide (H₂S) gas emissions. The predicted noise levels obtained by modeling the two power plants indicated that all settlements inside the 35 dB (A) contour were to be relocated as this land was predicted to be affected by noise levels above the National Environment Management Authority (NEMA) recommended night time permissible levels. On the other hand the predicted 24 hour average due to H₂S emission from Olkaria I unit 4 & 5 and Olkaria IV power plants was not permitted to be

above 0.10ppm (0.15 mg/m³), beyond the immediate power station boundary according to World Health Organization (WHO) guidelines. The Maasai communities (pastoralists) living in four villages within the projects' area of influence were therefore impacted. These villages were Oloonogot, Oloosinyat, Olomayiana ndogo and the Maasai Cultural Centre. A total of 335 households were affected.

4.2 Allocation of Employment and Economic Opportunities

Large scale projects like the 280MW Olkaria geothermal power plants generate employment and economic opportunities. Each of the two power plants provides temporary employment to about 1,200 unskilled labour totaling to 2,800. Economic opportunities include provision of catering and transport services to the various contractors and supply of locally available construction materials. Unless the criteria of hiring temporary employees and awarding contracts for existing economic opportunities is well defined and managed, this can result to demonstrations by the local communities and disruption of construction activities as it has been occasionally witnessed at Olkaria.

4.3 Habitat Connectivity

Olkaria I unit 4 & 5 power plant is located within Hells' Gate National Park about 10km away from Olkaria IV power plant. Therefore the two power plants and their associated infrastructure are located in an ecological sensitive area. Unless proper design of the steam gathering system is taken into consideration, the pipelines have the potential of obstructing animal corridors and dispersal areas resulting to habitat fragmentation. This can result to significant impacts on wild animals in the park.

4.4 Solid Waste Generation

Large volumes of solid waste are generated especially during delivery of heavy machinery, equipment and steam line parts for the construction of the power plant and the steam gathering system. The categories of solid waste generated include; empty cement bags, polythene papers, cartons, wooden boxes, empty plastic containers and biomedical waste from the onsite clinic and as a result of first aid administration. Unless proper mechanism of handling all the solid waste generated is established, such waste can become a source of public nuisance and aesthetic degradation.

4.5 Noise Emission

Noise emission result from grinding operations, percussion drilling, use of generators for power supply and well blow out prior to connection of steam pipelines and during testing of the power plant. This sources emit noise levels greater than 85 dB(A) which is the recommended noise level for an eight hour shift.

4.6 Soil Erosion

Site clearing and excavation works for the power plant installation resulted to creation of steep slopes which if left unattended have the potential of resulting to soil erosion and subsequent sedimentation of Lake Naivasha.

4.7 Health and Safety Aspects

Implementation of the proposed project has been associated with health and safety risks by virtue of the large volumes of materials and heavy equipment being transported and handled at the sites. From 2012 upto date the two power plants have recorded three fatal accidents and a number of near misses confirming the sensitivity of the health and safety aspects.

5. IMPLEMENTATION OF MITIGATION MEASURES

5.1 Resettlement Action Plan (RAP) for Involuntary Resettlement

To address involuntary resettlement, KenGen commissioned Gibb Africa Ltd to prepare a Resettlement Action Plan (RAP) to facilitate involuntary resettlement of the Project Affected Persons (PAPs). Good practice is to include formal land acquisition in project specifications (World Bank, 2004). KenGen treated the resettlement aspect as an integral component of the development process and devoted the same level of effort and resources to resettlement preparation and implementation as to the rest of the 280MW project. This is because implementing resettlement as a development program not only helps the people who are adversely affected but also promotes easier, less-troubled implementation of development projects. The RAP was therefore developed with reference to Kenyan and International Standards. Through a participatory consultative process, KenGen and the Project Affected Persons (PAPs) agreed on land for land compensation. The RAP process included negotiations between KenGen and Community Representatives leading to an agreement on the size of land measuring 1700 acres to be provided to the PAPs.

According to the RAP, it was agreed that KenGen was to construct the following facilities and infrastructure as part of the entitlements for the PAPs: a school complete with teachers quarters, 150 three roomed masonry housing units with detached pit latrines, bathrooms and kitchens, 3 churches with three roomed pastors houses, a social hall, a cattle dip, two fish ponds, a dispensary, water supply network with common watering points, electricity connection to the school and dispensary and earth roads providing access to and from the site. In addition, it was agreed that KenGen was to meet the cost of installing the electricity network throughout the resettlement site to facilitate application to Kenya Power and Lighting Company for connection in individual houses at the cost of the PAPs. This is in line with the World Bank Operational Policy 4.12 which describes the Bank's policy and procedures on involuntary resettlement. According to this Policy, all displaced persons should be compensated for their losses with full replacement cost prior to the actual move, assisted with the move and supported during the transition period in the resettlement site. The PAPs should be assisted in their efforts to improve their former living standards, income earning capacity and production levels. Land, housing, infrastructure and other compensation should also be provided to affected populations that might only have usufruct or customary rights to the land or other resources lost as a result of the project.

An agreement for accepting the resettlement land was entered between KenGen and representatives of the PAPs including village chairmen, elders, women leaders and youths. Signing of the agreement was witnessed by the Deputy County Commissioner, Naivasha sub-county and two lawyers each representing the PAPs and KenGen. The agreement spelt out conditions that were to be fulfilled by KenGen prior to relocation. These conditions were honored by KenGen hence increasing the level of confidence in the participation process.

KenGen and the representatives of the PAPs in presence of their preferred lawyer signed a Memorandum of Understanding (MoU) on the entitlements of the PAPs. The MoU was binding to both parties and it clearly outlined how the PAPs were going to be compensated. The entitlements were as provided for in the RAP document.

5.2 Stakeholder Involvement in Project Monitoring

One way to help satisfy stakeholder concerns and promote transparency is to involve project-affected stakeholders in monitoring the implementation of mitigation measures or other environmental and social programs (IFC, 2007). Stakeholder institutional arrangements were put in place to handle concerns of the stakeholders involved in the implementation of the 280MW projects in a timely, participatory and efficient manner. A lot of weight was placed on the PAPs. The following institutions were established with clear Terms of Reference.

- i. Stakeholders Consultation Committee (SCC)
- ii. Resettlement Action Plan Implementation Committee (RAPIC)
- iii. Project Implementation Team (PIT)

SCC was established as an umbrella institution to address stakeholder concerns pertaining to the overall implementation of the two power stations and the facilities for resettling the PAPs. The SCC has three sub-committees which include economic opportunities, Safety Health & Environment (SHE) and Employment opportunities sub committees. Composition of the SCC is drawn from Government Ministries, professionals, the local administration, women representatives, the PAPs, Nongovernmental organizations (NGOs), politicians (Members of County Assembly), vulnerable groups, youth representatives, KenGen staff and other nominees from Narok, Kajiado and Naivasha sub-counties. The chairperson and the secretary to the SCC are KenGen staff. The SCC and its sub-committees conducts separate and joint meetings on a monthly basis. The economic opportunities subcommittee is responsible for identifying like contracts for supply of construction materials, provision of transport services to the construction workforce and provision of catering services aimed at generation of income to the local community. The contracts are announced to the local community to facilitate submission of expression of interest to the subcommittee for evaluation and recommendation for award of contract. The SHE subcommittee handles complaints from the stakeholders concerning environment health and safety aspects. They visit construction sites and prepare reports on their findings for presentation to the SCC for deliberations. KenGen has employed an employment officer for the 280MW project who liaises with all contractors for identification and listing of job opportunities with respect to the desired qualifications. He presents this list to the employment subcommittee for deliberation and placement. The purpose of the economic and employment subcommittees was to ensure that majority of the unskilled labour, supplies of locally available construction materials and service providers came from the local community as specified in the ESIA study reports. Eighty percent of the employment and business opportunities are set aside for the PAPs.

RAPIC was established to ensure that the RAP is implemented in a manner that safeguards the entitlements of the PAPs. RAPIC derives its representation from the four RAP villages, Sub-county Administration, KenGen and government line ministries. Community representation in the RAPIC was through elections held by each of the four affected villages. To ensure meaningful elections, the PAPs were sensitized on the need to elect members who were capable of representing their interests during RAPIC meetings. Each village elected five representatives three of whom were men and two women. Additional members from the PAP communities include one youth representative and a vulnerable group representative elected from the four villages, a representative of the Maasai Cultural Centre Management Committee and a Maasai elder adding up to twenty four (24) PAPs. RAPIC members were presented to the PAPs for public ratification at a public disclosure meeting. The RAPIC meetings are chaired by the Deputy County Commissioner, Naivasha sub-county and the secretary is the Social Safeguards Advisor.

Because of the RAP component, the RAPIC conducts its meetings at least twice in a month or when need arises. SCC and RAPIC Meetings are coupled with visit to the project sites to facilitate in depth understanding of the issues. SCC and RAPIC were basically put in place as multi-stakeholder forums to provide a mechanism for debating issues concerning the PAPs thereby serving as vehicles through which broad agreement or consensus on the final conclusions was arrived at.

The PIT comprise of KenGen staff with various professional backgrounds including Engineers (mechanical, electrical, civil), legal officers, finance officers and Environment Health and Safety officers. The purpose of the PIT is to discuss cross cutting issues pertaining to the implementation of the 280MW. Deliberations of the PIT meetings are presented to the project contractor during the monthly progress meetings for compliance purposes. The resettlement project has a separate PIT with similar composition of staff.

5.3 Incorporation of Animal Migratory Routes in the Design of the Steam Gathering System

KenGen and Kenya Wildlife Service conducted a field survey with an aim of mapping out all the animal migratory routes and corridors between Olkaria IV and Olkaria I unit 4 and 5 power plants. This was undertaken in 2010 prior to the commencement of construction works. The map generated was issued to the consultant (SKM) who was awarded the contract of designing the power plant and the associated steam gathering system. Through map overlays, the consultant avoided some ecologically sensitive areas while providing for animal passes, raised loops and buried pipelines, to maintain movement of wild animals. The same consultant is being used to supervise construction and commissioning of the power plant hence ensuring that the design is implemented to the latter.

5.4 Site Inspections and Audits

The consultant for the 280MW projects employed an Environment Safety and Health (ESH) Manager charged with the overall responsibility of ensuring implementation of the Environmental Management Plan by all contractors including their subcontractors. This is achieved through planned and impromptu walkthrough site inspections. The manager undertakes the audits single handedly or jointly with the contractors' SHE officers. Any non compliance observed is documented and reported to the concerned contractor for closure within the agreed time frame. Where safety is endangered, the action taken entails suspending operations until the safety aspect is adequately addressed. The manager has also the authority to dismiss a worker violating the agreed safety measures e.g failure to use personal protective equipment. Each contractor has also adequate number of environment health and safety officers who enforce implementation of the EMP and job safety analysis. Audits entail physical verification of the task being undertaken to verify if the practice matches the documented procedure.

KenGens' environmental and safety officers also conduct site inspections on a weekly basis and submits the inspection reports to the ESH Manager through the Resident Engineer for implementation of recommended actions. Any pending issue is discussed during the PIT meetings. Records providing full details of the various audits conducted are maintained.

5.5 Soil Stabilization Technique and Rehabilitation Works

Use of hydro seeding technology that utilizes geo web membrane (cellars) is being used stabilize soils on steep slopes. The technology entails broadcasting grass seeds within the geo web membrane and watering until the grass sprouts as shown in the photo below. Once the grass has grown, it will prevent soil erosion on steep slopes. Stone pitching is also used in some selected areas.



Plate 1: Photo Showing Grass Planted at Olkaria IV site Using Hydro Seeding Technology

5.6 Management of Health and Safety Aspects

5.6.1 Documentation of Standard Operating Procedures

Each contractor and subcontractor is required to prepare Job Safety Analysis (JSA) and method statements which are submitted to the consultant for approval by the Environment Safety and Health Manager prior to commencement of works. The method statements indicates the scope of works, the personal responsible for supervision of the work, duration of works, critical risks, how the work will be carried out and the mitigation measures for the risks involved. The JSA on the other hand indicate the type of task, hazards involved and the precautions to be observed to ensure health and safety of workers. Other documented procedures include working at height. Documentation of standard operating procedures is in line with Environmental Management Systems ISO 14001:2004 standard for which KenGen is certified. This ensures commitment on the part of the contractor to implement the Environmental Management Plan.

5.6.2 Use of Permit to Work

The permit to work is used for activities deemed to endanger health and safety of staff including: cold works, excavation, hot works, lifting operations, working in confined space and electrical installations. The permit to work indicates the work to be done, hazards involved & health and safety precautions to be taken before, during & after work. All permits to work are signed by the contractors' safety officers and the workers involved before and after work. For this reason, a permit to work is taken depending on the activity of the day and all safety measures listed in the permit must be followed to the latter.

5.6.3 Provision and Use of Personal Protective Equipment

All workers and visitors entering construction sites must wear personal protective equipment. Proper PPE is mandatory depending with the type of work on site. Mandatory PPEs for all workers on site comprise of a reflector jacket, safety shoes, coveralls and helmets whereas for visitors, a reflector jacket, safety shoes and a helmet should be worn. Other PPEs provided to workers depending with the nature of work and the hazards involved include safety goggles, ear protectors, welding screens, hand gloves and hooked safety harness. Enforcement of the use of PPEs is done by the contractor's safety personnel. Appropriate signages for the recommended PPEs have been conspicuously displayed as a reminder to workers and visitors.

5.6.4 Noise Level Measurement

KenGens' environment section carries out daily measurement of noise levels at the construction sites. The results are communicated to the resident engineer for decision making i.e advising workers to use ear protectors where noise levels exceed 85 dB (A).

5.6.5 Toolbox and Occupational Safety and Health (OSH) Committee Meetings

Every morning all employees must assemble for tool box meetings prior to commencement of works. Here the employees are allocated the day's tasks and informed of the potential hazards related to each task and possible mitigation measures. The toolbox meetings are usually interactive to allow workers to take part in the discussions. Before any critical activity, the workers involved in the activity must have their own toolbox meeting before commencement of works to allow them divide roles and to know the sequence of activities and whoever is responsible for what. This assists to make the workers aware and knowledgeable of the safe method statements in a simplified manner.

Workers' representatives appointed by each contractor under the 280MW project comprise the Occupational Safety and Health Committee. The meetings are held on a monthly basis. It is during these meetings that workers welfare, health and safety are discussed. An action plan resulting from each meeting is communicated to the rest of the workers. The ESH Manager oversees implementation of the action plan.

5.6.6 Safety Briefings/Induction

Every new worker employed or visitor entering the construction site is required to undergo a mandatory safety briefing/induction. This entails relay of prior information on the likely hazards to be encountered, safety precautions to be observed while on site and emergency response plan and evacuation procedures in place. The safety induction is carried out by the contractor's safety officer.

5.6.7 Documentation of Accidents/Incidents

Accidents, incidents and near misses are investigated for determination of root causes, recommendation of measures to prevent recurrence of similar incidents and improvement of safety performance at the site. These measures are communicated to the workers for compliance purposes. A fatal accident occurred at Olkaria I unit 4 & 5 site on 4th February 2013 as a result of using a mobile phone while directing a reversing truck on site. From hence forth use of mobile phone on site was prohibited via a memo which was conspicuously displayed as had been recommended in the accident report. Any non compliance leads to confiscation of the phone and expulsion from the site.

5.6.8 First Aid Provision

A clinic with a full time nurse managed by the main contractor (Hyundai) was set up to address any emergencies requiring medical attention. In order to strengthen emergency preparedness, each contractor has trained first aiders and adequate number of first aid kits on site. Critical conditions are referred to the government hospital located in Naivasha town, about 40Km away.

5.6.9 Supervision of Workers

The foremen, supervisors and safety personnel must be on site always and especially during critical activities. This provides an opportunity for them to correct unsafe acts and conditions during execution of specific tasks associated with those activities.

5.6.10 Use of Signaler/Banks Men to Direct Trucks

All drivers delivering materials to the construction sites are instructed by designated banks men/signalers to ensure safety of other road users and workers on site.

6. LESSONS LEARNT

The following lessons can be deduced from implementation of the 280MW projects.

- i. The magnitude of the activities at the two power plants, Olkaria IV and Olkaria I unit 4 & 5, is immense hence there was need for the consultant (SKM) to deploy an ESH manager under each project as opposed to having one manager.
- ii. There was need for the consultant to deploy an ecologist to advice in the design of the steam gathering system considering the ecological sensitivity of Hells' Gate National park
- iii. The environmental officer and safety officer from KenGen side should have been involved to monitor implementation of EMP on a full time basis in the same way the Resident Engineer was working. This would have helped to address issues picked by the two officers immediately unlike in the present case where non compliance issues have to pass through the Resident Engineer for submission to the ESH Manager for closure.
- iv. The Stakeholders Coordination Committee did not incorporate someone from Kenya Wildlife Service which is a key stakeholder with respect to management of Hells' Gate National Park. Personnel from KWS would have provided an insight into the design and construction of the steam gathering through the established Environment Health and Safety subcommittee considering the fact that mapping of the animal migratory routes and corridors had been done jointly with KenGen.
- v. A lot of attention was placed on mitigation of safety and social aspects as opposed to aspects related to the physical environment including control of invasive species at disturbed sites within the park and sound management of solid waste. Segregation of solid waste from the point of generation was not being adequately managed. This shortcoming

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resulted from the way the contract for executing works was designed. The contract did not clearly state how the various wastes were going to be finally disposed by each contractor in line with the Environmental Management and Coordination (Waste Management) Regulations, 2014. Such solid waste comprised of large volumes of scrap timber which were being used for packaging of machine parts and equipment. This calls for the need to envisage all categories of solid waste to be generated and how each type of solid waste will be handled from the point of generation to final disposal site.

- vi. Despite the high influx of workers to the sites (over 1200 per site), there was no component for HIV/AIDS awareness creation. This was because the contract did not specify whose responsibility was it to carry out awareness creation. This is a component of the project that requires a substantial amount of money to implement hence many contractors would try to avoid it in order to save on cost.
- vii. Construction of such magnitude exposes workers to a lot of safety risks hence the need for a standby ambulance in line with good international practice. Normal cars were used to transport casualties to the clinic and referral hospitals in Naivasha hence compromising the effectiveness of emergency response.
- viii. Effective stakeholder management during construction phase of large scale geothermal projects involving involuntary resettlement of project affected persons can bring about timely delivery of projects.
- ix. A holistic approach is required in the drafting of the contract for construction of large scale geothermal projects if a balanced and affective way of addressing social, environmental and safety aspects has to be achieved.

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